Radar
#338
62

CIVIL AERONAUTICS ADMINISTRATION INSTRUCTION BOOK

FOR THE

MODEL 976 ELECTRONIC MULTIMETER

Manufactured by

WESTON ELECTRICAL INSTRUMENT CORPORATION
NEWARK 5, NEW JERSEY, U. S. A.

MP MASTER
MA35466

CONTRACT CcA 28721

DATED JUNE 28, 1950

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_07056

CIVIL AERONAUTICS ADMINISTRATION INSTRUCTION BOOK

FOR THE

MODEL 976
ELECTRONIC MULTIMETER

Manufactured by

WESTON ELECTRICAL INSTRUMENT CORPORATION
NEWARK 5, NEW JERSEY, U. S. A.

SAFETY NOTICE

Attention is directed to Section 3, MANOP LV-A-4, Maintenance of Electronic Equipment.

Because of the high voltages which are normally present in the equipments on which this instrument may be used extreme care should be exercised to avoid the possibility of electrical shock during the course of test procedures.

Dangerous voltages are present within the instrument and also on the capacitor test terminals, E-2 and E-3, during the capacitor leakage tests. After a capacitor has been tested for leakage it should be discharged by slowly rotating the CAPACITOR VOLTAGE control to its maximum counter-clockwise position.

RESUSCITATION:

Personnel should familiarize themselves with the resuscitation method which is described in the first aid manual.

GUARANTEE

The equipment including all parts and spare parts, except vacuum tubes, batteries, natural rubber and material normally consumed in operation, is guaranteed for a period of one year from installation and commissioning by the Government, but not more than two years from the date of delivery of the equipment to and acceptance by the Government with the understanding that all such items found to be defective as to material, workmanship or manufacture will be repaired or replaced, f.o.b. any point within the continental limits of the United States designated by the Government, without delay and at no expense to the Government, provided that such guarantee will not obligate the Contractor to make repair or replacement of any such defective items unless the defect appears within the aforementioned period and the Contractor is notified thereof in writing within a reasonable time and the defect is not the result of normal expected shelf life deterioration.

If 20 percent or more of the total quantity of any part or component to which the above guarantee applies, but not less than two of any such part or component furnished under the contract, are found to be defective, that fact shall be conclusive evidence that the particular part or component is unsuitable for the purpose intended and the contractor shall replace or correct it in a manner satisfactory to the Government in all equipments, parts and spare parts without cost to the Government unless the use of such part or component is directed by the Government, and if the defective part or component is of the contractor's design or of a design selected by the contractor, it shall be replaced by the contractor by a suitably redesigned part or component.

The above guarantee period shall not include any period of time the equipment fails to perform satisfactorily due to any such defect and any item repaired or replaced by the contractor pursuant to this guarantee shall be guaranteed anew under the same conditions for a further period of one year.

The contractor may elect to have any defective or damaged item returned to his plant, he to pay the return transportation charges, but he shall not delay the prompt replacement of the defective or damaged item. If, upon the examination of the defective or damaged item, it can be shown to the satisfaction of the Government that the item is not defective within the meaning of this guarantee, the contractor may bill the Government for the cost of replacement, including transportation.

TABLE OF CONTENTS

PARAGRAPH		PAGE
	Safety Notice	II
	Guarantee	III
	Summary Sheet	VI
	SECTION I - GENERAL DESCRIPTION	
1	Equipment and Accessories	1
2	Basic Theory of Operation	2
	SECTION II - THEORY OF OPERATION	
1	D.C. Volts Normal	3
2	D.C. Volts Reverse	3
3	D.C. Volts Zero Center	3
4	High Voltage D.C. Probe	4
5	A.C. Volts	5
6	1200 Volts A.C.	6
7	R.F. Volts	6
8	Peak R.F. Volts	6
9	Peak A.C. Volts	6
10	D.C. Milliamperes	6
11	Ohmmeter	7
12	Electrolytic Capacitor Leakage	7
13	Capacity	8
	SECTION III - INSTALLATION AND INITIAL ADJUSTMENTS	
1	Installation	9
2	Initial Adjustments	9
	SECTION IV - OPERATION	
1	General	10
2	A.C. and R.F. Measurements	11
3	Step-By-Step Operating Instructions	12
4	Precautions	19
	SECTION V - PREVENTIVE MAINTENANCE	
1	H.V. Probe Inspection	20
2	Fuses	20
3	Battery Inspection	20
4	Storing the Instrument	20
5	Fungus Proofing	20
	SECTION VI - CORRECTIVE MAINTENANCE	
1	Trouble Shooting Notes	21
2	Adjustments	21
3	Additional Trouble Shooting Chart Cross Reference	21
4	Voltages	23
	SECTION VII	
1	Parts List	30
2	List of Manufacturers	43

FIGURE	LIST OF ILLUSTRATIONS	PAGE
1	Model 976 and Accessories	VIII
2	D.C. Volts Normal Circuit	3
3	D.C. Volts Zero Center Circuit	4
4	H.V. Probe Circuit	4
5	H.V. Probe Assembly	5
6	A.C. Volts Circuit	6
7	D.C. Milliamperes Circuit	7
8	Ohmmeter Circuit	7
9	Electrolytic Capacitor Leakage Circuit	8
10	Capacity Circuit	8
11	Model 976 with Cover Closed	9
12	Model 976 Front Panel	10
13	Frequency Correction Curve for R.F. Probe	11
14	R.F. Probe Chassis Connections	22
15	Schematic Diagram of Model 976 Electronic Multimeter	45
16	Model 976 Rear Panel less Sub-Chassis Assembly	46
17	Model 976 Sub-Chassis Assembly	47
18	Model 976 Rear Panel Complete	48

TABLE	LIST OF TABLES	PAGE
1	A.C. and R.F. Connections	12
2	Decible Correction Table	15
3	Resistance Range Selection	17
4	Rated Working Voltage	18
5	Trouble Shooting Chart	24
6	Winding Data	29

SUMMARY SHEET

1. Model 976 Electronic Multimeter

2. Procurement Specification - CAA-5285 dated 5/22/50

3. Ranges:

   A. D.C. VOLTS (electronic; normal and reverse polarity)
      6 Ranges: 0-3, 12, 30, 120, 300 and 1200 volts
      Input impedance - 15 Megohms on all ranges
      Accuracy: ±3%

      D.C. VOLTS (zero center available on D.C. reverse polarity only)
      6 Ranges: 1.5-0-1.5, 6-0-6, 15-0-15, 60-0-60, 150-0-150 and 600-0-600 volts
      Input impedance - 15 Megohms on all ranges
      Accuracy: ±3%

      D.C. H.V. PROBE
      6 Ranges: 120, 480, 1200, 4800, 12,000 and 48,000 volts
      Input impedance - 600 Megohms on all ranges
      Accuracy: ±5%

   B. A.C. VOLTS (R.F. Probe in socket)
      6 Ranges: 0-3, 12, 30, 120, 300 and 1200 volts
      Input impedance - 5 Megohms and 150 mmfd on all ranges
      Frequency Range: 20 to 50,000 cycles
      Accuracy: ±5%

   C. R.F. VOLTS (R.F. Probe direct)
      5 Ranges: 0-3, 12, 30, 120 and 300 volts
      Input impedance - 5 Megohms and 5 mmfd on all ranges
      Frequency Range: 3000 cycles to 300 Megacycles
      Accuracy: 0.003 to 150 Megacycles ±5%: 150 to 300 Megacycles (with correction chart), ±5%

   D. PEAK R.F. VOLTS (R.F. Probe direct)
      5 Ranges: 0-3, 12, 30, 120 and 300 volts
      Input impedance - 5 Megohms and 5 mmfd on all ranges
      Frequency Range: 3000 cycles to 300 Megacycles
      Accuracy: 0.003 to 150 Megacycles ±5%: 150 to 300 Megacycles (with correction chart), ±5%

   E. PEAK A.C. VOLTS (R.F. Probe direct with bakelite housed capacitor screwed on tip)
      5 Ranges: 0-3, 12, 30, 120 and 300 volts
      Input impedance - 5 Megohms and 10 mmfd
      Frequency Range: 60-50,000 cycles
      Accuracy: ±5%

   F. D.C. - MA (Non Electronic)
      6 Ranges: 0-3, 12, 30, 120, 300 and 1200 MA
      Accuracy: ±3%

see EEM 122 Attachment 4 re Insulation Resistance Testing.

G. OHMS (Electronic)

6 Ranges:	MULT	RANGE	CENTER SCALE
	R x 1	0-2000 ohms	30 ohms
	R x 10	0-20,000 ohms	300 ohms
	R x 100	0-200,000 ohms	3,000 ohms
	R x 1000	0-2 Megohms	30,000 ohms
	R x 10,000	0-20 Megohms	300,000 ohms
	R x 1 Megohm	0-2,000 Megohms	30 Megohms

Accuracy: ±10% of actual value

H. CAPACITY

4 Ranges:		
	C x 100 mmfd	10 mmfd to 5000 mmfd
	C + 100 mmfd	.001 mfd to 0.5 mfd
	C x 1 mfd	0.1 mfd to 50 mfd
	C High Range	26 mfd to 1000 mfd

Accuracy: ±10% of actual value (100 mmfd to 500 mmfd)

I. ELECTROLYTIC CAPACITOR LEAKAGE

0-3 and 0-30 MA (Electronic)

Accuracy: ±3%

J. POWER FACTOR

0-50% PF. available on C x 1 and C High Range

Accuracy: ±10%

K. CAPACITOR POLARIZING VOLTAGE (Used only for Capacitor Leakage Tests)

Continuously variable from 0 to 500 volts

4. POWER SOURCE

105-125 volts A.C. -50-60 cycles

1-1/2 volt unicell is required to energize the ohmmeter measuring circuit

5. TUBES AND ACCESSORIES

1 6X4 Full wave rectifier
1 12AU7 Tube voltmeter amplifier
1 991 Voltage regulator for zero center ranges
1 CK 5704 Diode for R.F. Probe
1 HV Probe (Insulated for 50,000 volts, but not to be used on voltages exceeding 30,000 volts)
1 R.F. Probe
1 R.F. Probe ground clip
2 Test leads
1 Low Frequency Capacitor Adapter Tip (C-14)

6. WEIGHT

20 - 1/2 lbs. crated: 18 lbs. uncrated.

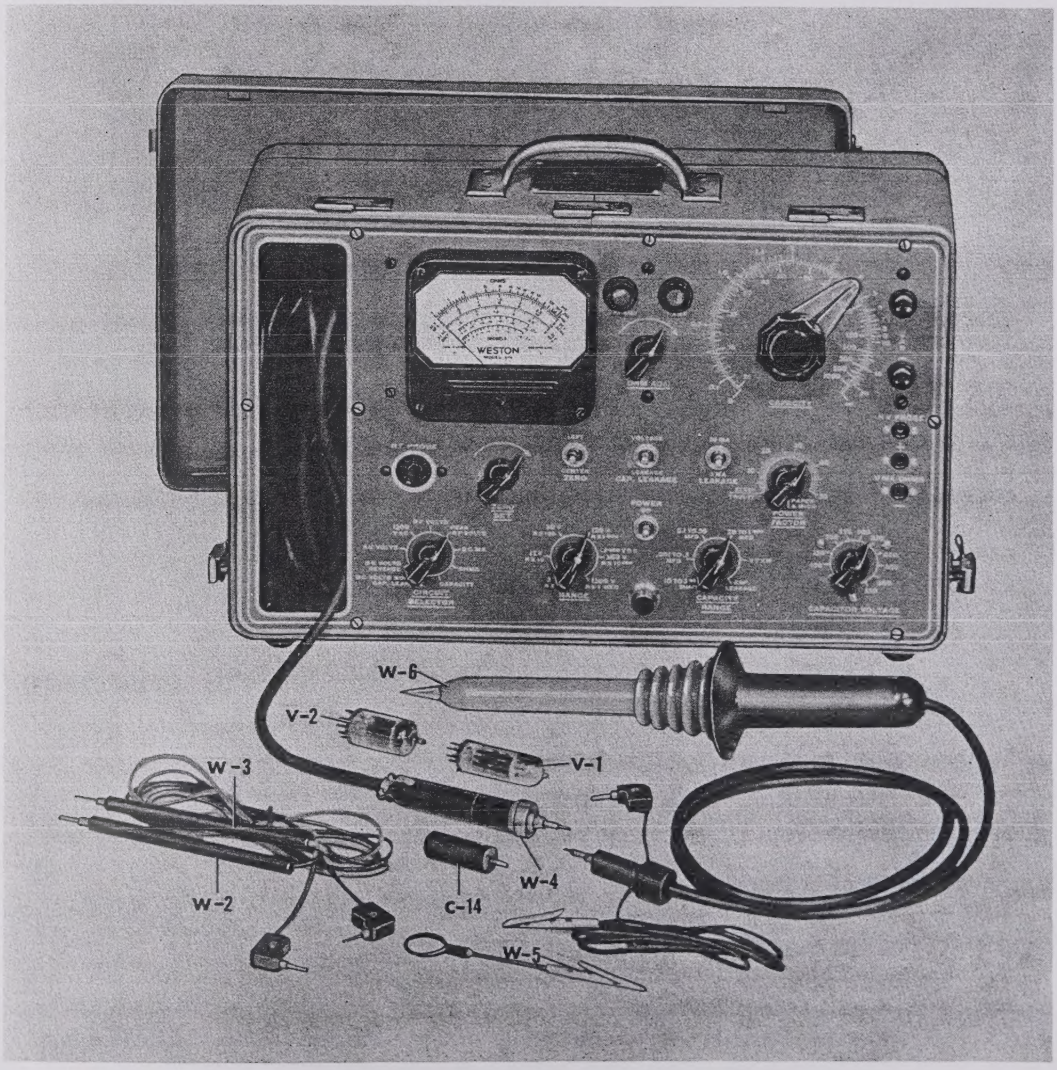


Figure 1. Model 976 and Accessories

SECTION I

GENERAL DESCRIPTION

1. EQUIPMENT AND ACCESSORIES

A. The Model 976 is a combination electronic voltohmmeter, milliammeter and capacitance analyzer. It is mounted on an aluminum panel and housed in an aluminum case, (see Figure 1). A storage compartment, located in the left-hand section of the case is provided for storing the accessories and operating spare parts.

B. RANGES

a.	Volts, AC rms and DC:	Six ranges, 0-3, 12, 30, 120, 300 and 1200 volts.
b.	Volts, R.F. rms:	Five ranges, 0-3, 12, 30, 120 and 300 volts.
c.	Volts AC Peak:	Five ranges, 0-3, 12, 30, 120 and 300 volts.
d.	Volts R.F. Peak:	Five ranges, 0-3, 12, 30, 120 and 300 volts.
e.	Current DC:	Six ranges, 0-3, 12, 30, 120, 300 and 1200 milliamperes.
f.	Capacity:	Four ranges, 10 to 5000 mmfd, 0.5, 50 and 1000 mfd.
g.	Ohms:	Six ranges, 0-2000, 20,000, 200,000, 2,000,000, 20,000,000 and 2,000,000,000 ohms.

C. The accessories (see Figure 1) consist of:

a. One High Voltage Probe
b. One BLACK test lead
c. One RED test lead
d. One R.F. Probe
e. One LOW Frequency Capacitor Adapter Tip

D. The operating spare parts consist of:

a. One #47 Pilot Lamp, 6.3 volts, 150 MA. Miniature Bayonet Base
b. One 2 ampere fuse (auto type)
c. One 1/32 ampere fuse (auto type)
d. One 991 voltage regulator
e. One 6X4 full wave rectifier
f. One 12AU7 amplifier
g. One CK5704 diode

2. BASIC THEORY OF OPERATION

The Model 976 Electronic Multimeter uses a twin triode in a balanced DC amplifier circuit. AC voltages, RF voltages and Peak RF voltages are measured by means of a diode mounted in an external probe. The DC output of this diode is fed into the vacuum tube voltmeter circuit.

Values of Capacitance are measured on a simple Wien bridge. The 3 volt AC range is used for null indications.

An AC power source of 105-125 v AC is required to operate this instrument except when measuring direct current - all ranges (DC-MA). Current measurements of this type involve the use of a ring shunt which is connected directly to the indicating instrument, hence no power source is required.

SECTION II

THEORY OF OPERATION

1. D.C. VOLTS NORMAL

The Model 976 Electronic Multimeter uses a twin triode (V-2) in a balanced DC amplifier circuit (see Figure 2). A DC meter connected across the two plates (pin 1 and 6 of V-2) indicates the difference in the plate potentials. Under the conditions of zero input voltage on the control grid, (pin 2) and equal plate currents, the circuit is balanced. The resistance of R-33 is equal to the resistance of R-32, therefore, equal plate currents produce equal voltage drops across these resistors and the plate potentials of both sections of the tube are equal.

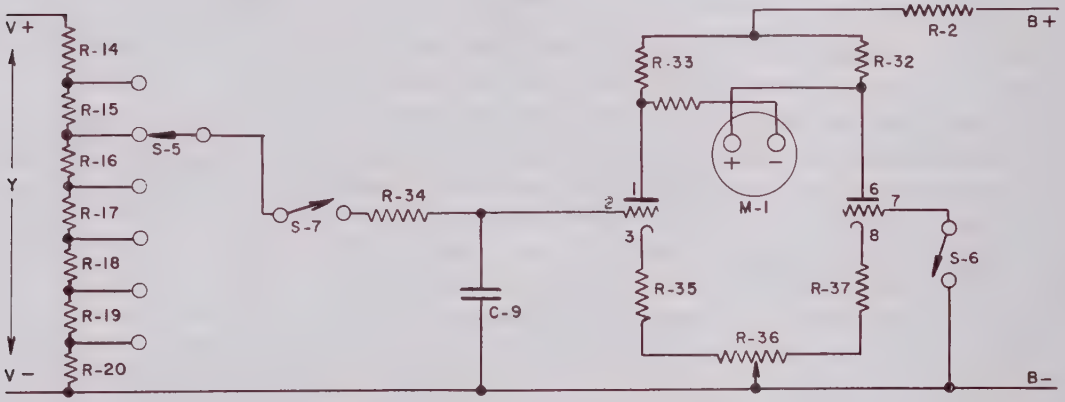


Figure 2. D.C. Volts Normal Circuit

A zero set control (R-36) is required to compensate for the slight differences in the electrical characteristics of the two sections of the tube and of other circuit components. To equalize the plate currents, the cathode resistance of the section with the higher plate current must be increased and that of the section with the lower plate current decreased. This is done by turning the zero set control (R-36) in the proper direction until the meter reads zero. After the circuit is balanced, input voltages can be applied and measured. When a positive input voltage is applied to grid (2) the current of plate (1) increases, resulting in a larger voltage drop across resistor R-33 and a decrease in the potential at plate (1). Since grid (7) is grounded no change in plate current takes place in plate (6), therefore, the voltage drop across resistor R-32 remains the same and the potential at plate (6) is unchanged. A difference in plate potentials now exists which can be measured on the indicating instrument, (M-1). Stability is obtained by the use of relatively high values of cathode resistance R-35 and R-37. Input voltages may be varied by means of the voltage divider Y which has a total resistance of 15 megohms for all ranges. Capacitor C-9 prevents electrostatic charges from reaching the grid of the tube.

2. D.C. VOLTS REVERSE

The operation of this circuit is the same as DC VOLTS NORMAL, with the exception that the connections to the meter are reversed from those shown in Figure 2.

3. D.C. VOLTS ZERO CENTER

The operation of this circuit is the same as DC VOLTS REVERSE, with the exception

SAFETY FIRST

that a voltage regulator (V-3) has been added to provide a positive voltage for grid (7) in order to produce a half-scale meter deflection, (see Figure 3). Under the condition of zero volts input on grid (2), and exact center-scale meter deflection is obtained by pro-

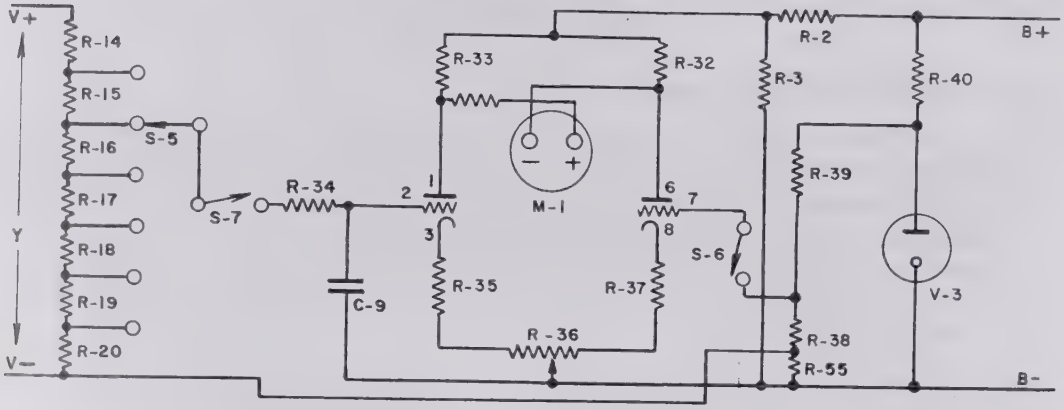


Figure 3. D.C. Volts Zero Center Circuit

perly adjusting the Zero Set control (R-36). The circuit is still balanced because the cathode resistors are still approximately equal to each other. Application of negative voltages to grid (2) will increase and positive voltages will decrease the deflection of the meter (M-1).

4. HIGH VOLTAGE PROBE

SAFETY FIRST

This circuit is the same as DC VOLTS NORMAL or REVERSE, with the exception that a very high resistance is connected in series with the voltage divider, (see Figure 4). This resistor is mounted in the probe. A resistance of 585 megohms was chosen to provide a range of 12,000 volts when the RANGE switch is indexed to 300 volts.

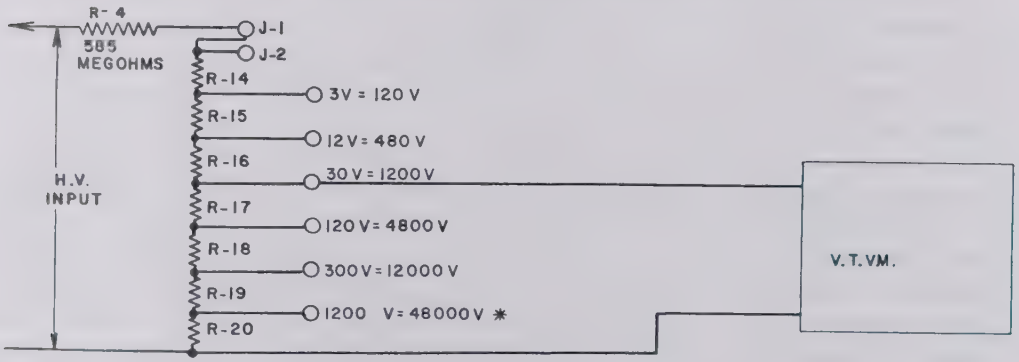


Figure 4. H.V. Probe Circuit

Note: The H.V. Probe is insulated for 50,000 volts, however, do not attempt to use it in circuits when the potential exceeds 30,000 volts.

Using a 585 Megohm resistor in the probe provides a 40 to 1 increase in the voltage ranges shown on the panel. Example: the 30 volt range becomes a 1200 volt range when used with the probe. Do not use this probe on potentials over 30,000 volts. The table below gives the voltage ranges using the 585 megohm resistor.

SAFETY FIRST

SAFETY FIRST

Note: By using the H.V. Probe the input impedance is increased from 15 megohms to 600 megohms. This could be of great importance in circuits where a 15 megohm load would upset the operating characteristics of the device under test.

RANGE SWITCH SETTING	HIGH VOLTAGE RANGE USING H.V. PROBE
3	120 v
12	480 v
30	1200 v
120	4,800 v
300	12,000 v
1200	48,000 v

The use of the H.V. Probe can be dangerous unless it is used intelligently. Safety devices have been incorporated in the design of the probe, but unless they are used correctly, serious accidents may occur. Therefore, an explanation of the theory behind the ground and shielding system employed in this probe is in order.

The probe consists of a probe handle and a front section with fins all made of polystyrene, (see Figure 5). The increased length afforded by the fins provides protection against potentials as high as 50,000 volts. Furthermore, the spacing between fins is such that arc over through the air from fin tip to fin tip is impossible when used on potentials below 30,000 volts. The copper shielding on the face of the probe handle, the flange and the front section screw threads are grounded through a metal washer to the shielded cable. However, the shielding system of this probe will provide the needed protection only if the following connections are made: First, the alligator clip A, shown in figure 5, must be grounded to the chassis of the device on which high voltages are to be measured. Second, the elbow terminal B must be in the negative pin jack, J-3. Third, the banana plug C must be plugged into the positive pin jack, J-1.

CAUTION - TURN OFF EQUIPMENT BEING TESTED BEFORE MAKING THESE CONNECTIONS.

SAFETY FIRST

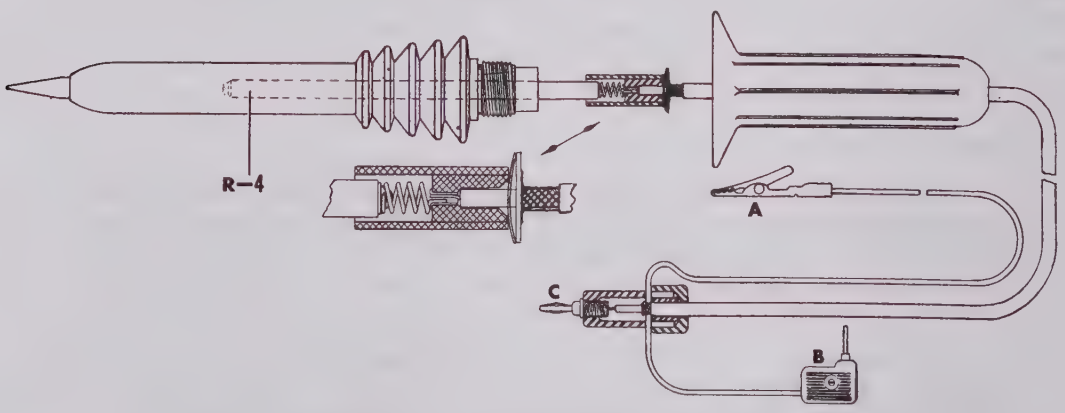


Figure 5. H.V. Probe Assembly

5. A.C. VOLTS

The AC voltage ranges are obtained by using a probe containing a diode rectifier V-4, a resistor R-54 and capacitor C-10 (see Figure 6). Capacitor C-7 is located in the AC V.T.V.M. circuit and acts as a filter. To measure low frequency AC volts the probe is

SAFETY FIRST

placed in the R.F. PROBE WELL (J-4) which automatically short circuits C-10 and connects a higher value capacitor C-6 in series with the input. The rectified output of the probe is measured by the V.T.V.M. It should be noted that this circuit rectifies in an

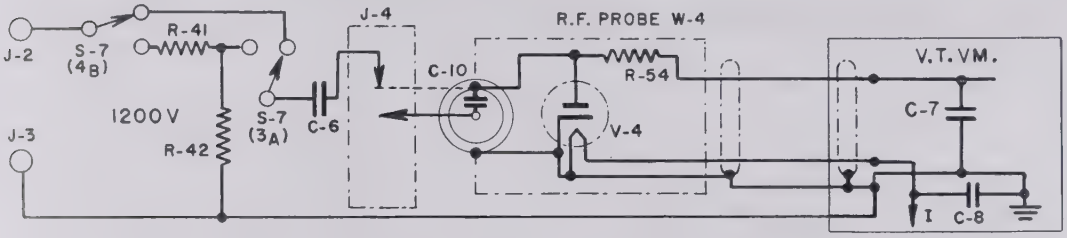


Figure 6. A.C. Volts Circuit

unusual manner. It is a half wave peak reading device calibrated to indicate in terms of R.M.S. voltage. When the instantaneous polarity of the AC input is positive, the diode conducts and current flows through the external source and begins to charge capacitor C-6. However, when the input voltage polarity is negative, the diode stops conducting and the capacitor C-6 fails to charge any further. Part of the charge already on the capacitor begins to leak off through the input voltage divider of the DC vacuum tube voltmeter. After a few consecutive cycles the capacitor becomes fully charged. From this point on, the source has only to replace the energy lost during the period when the tube is not conducting. Therefore, the probe draws very little current after the capacitor is once fully charged. Resistor R-54 and capacitor C-7 form a filter network.

6. 1200 VOLTS A.C.

This circuit is the same as AC volts except that a voltage divider is connected between the test leads and the rest of the circuit, (see Figure 6). The use of a voltage divider prevents the application of more than 12 volts to the probe.

7. R.F. VOLTS

For R.F. Volts, the probe is removed from the R.F. PROBE WELL (J-4) and the potential to be measured is applied directly to C-10 and the ground clip. Otherwise the theory of operation is the same as for AC VOLTS, (see Figure 6). The meter is calibrated to indicate R.M.S. values.

8. PEAK R.F. VOLTS

The operation of this circuit is the same as that of the R.F. VOLTS circuit. The meter sensitivity can be changed to read peak voltage direct by setting the CIRCUIT SELECTOR switch to PEAK R.F. VOLTS.

9. PEAK A.C. VOLTS

The operation of this circuit is the same as for PEAK R.F. VOLTS except that an external .01 mfd capacitor is screwed on the tip of the R.F. Probe. This capacitor is placed in series with the R.F. Probe and when in position shorts capacitor C-10.

10. D.C. MILLIAMPERES

These ranges use series and shunt resistors to vary the meter sensitivity, (see Figure 7). On the 1200 MA range the current divides and the major part of it flows through the shunt R-13 and the balance through the meter M-1 and series resistors R-8, R-9, R-10, R-11 and R-12. The current in each branch divides in inverse proportion to the

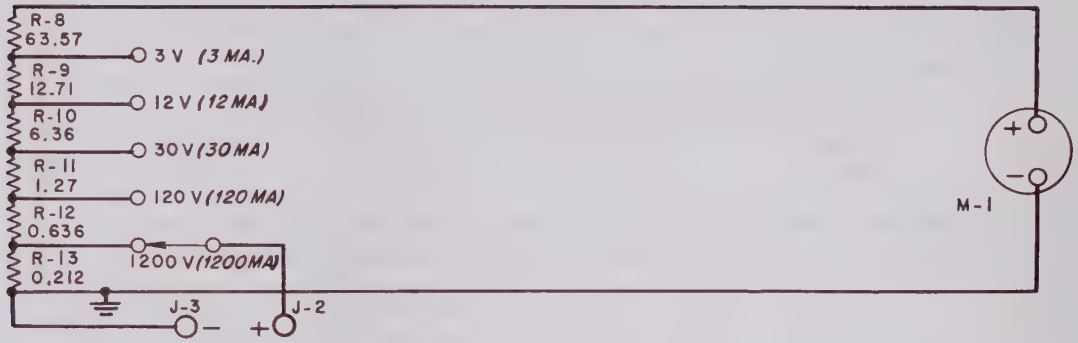


Figure 7. D.C. Milliamperes Circuit

total resistance of each circuit. The instrument does not have to be connected to a power source for the operation of this circuit.

11. OHMMETER

The series ohmmeter circuit is shown in Figure 8. The reverse DC volts section of the vacuum tube voltmeter, minus the input voltage divider, is used, in the circuit.

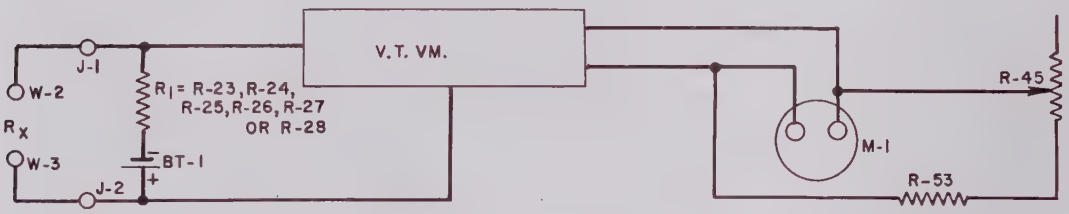


Figure 8. Ohmmeter Circuit

Resistors R_1, R_X and the battery (BT-1) form a series circuit. Looking at the entire circuit, the unknown resistor R_X is in parallel with R_1 and the battery BT-1. With infinite resistance across leads W-2 and W-3 the voltage drop across R_1 is zero and the entire battery voltage is applied to the input of the vacuum tube voltmeter. Sufficient current flows in the plate circuit to cause the meter pointer to deflect full-scale. When a resistance is placed across W-2 and W-3 there will be a voltage drop across R_1. Less voltage on the input of the vacuum tube voltmeter means less current will flow in the plate circuit. The meter polarity in the vacuum tube voltmeter section is so arranged that under this condition the deflection will decrease from the full-scale position. If R_X is equal to R_1 then the pointer will fall to half-scale. If R_X is zero the pointer will drop to zero. The value of R_1 is changed whenever a different range is selected. A sensitivity control (R-45) is provided for the purpose of compensating for a variation of battery voltage.

12. ELECTROLYTIC CAPACITOR LEAKAGE

The capacitor under test is connected across the binding posts E-2 and E-3. The voltage in this circuit is applied across the capacitor and can be varied by means of the capacitor voltage control R-1. To measure the voltage across the capacitor, the capacitor leakage toggle switch (S-2) must be in its spring-return position as shown in figure 9. When in this position the vacuum tube voltmeter is connected through the range switch (S-5) across E-2 and E-3. If S-2 is held in the leakage position, the vacuum tube voltmeter is connected across R-21 and R-22, and the 3 v range is automatically selected regardless

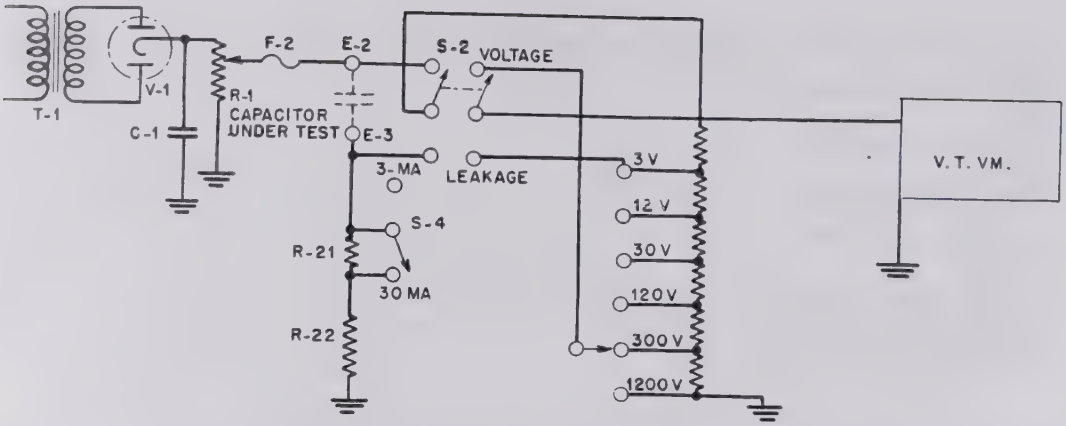


Figure 9. Electrolytic Capacitor Leakage Circuit

of the position of S-5. The leakage current range of 3 ma is selected by operating the leakage toggle switch S-4.

13. CAPACITY

This circuit consists of a simplified Wien bridge arranged as follows, (see Figure 10). A Wien bridge is similar to a Wheatstone bridge except that two of the resistance arms

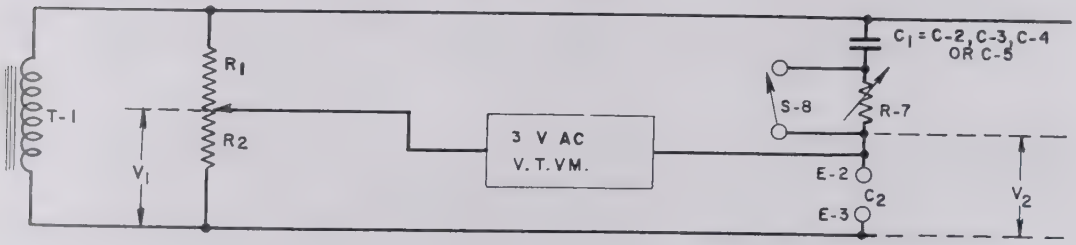


Figure 10. Capacity Circuit

are replaced with capacitive reactance. The 60 cycle energizing source T-1 is connected to the bridge and any of the AC voltage ranges may be used for indicating balance. Greater sensitivity is obtained by selecting the lower AC ranges. Resistors R_1 and R_2 make up a potentiometer (R-6) with the arm connected to one side of the Vacuum Tube Voltmeter. Resistor R-7 is a power factor control to be used when testing electrolytic capacitors. C_1 is a calibrated standard capacitor and C_2 is the unknown capacitor being tested. The bridge is in balance when $V_1 - V_2 = 0$ and will thus be indicated on the meter. Any current in R_1 must be the same as in R_2 and likewise any current in C_1 must also be the same as that in C_2. From the preceding discussion we get the following equations at balance. The bridge is balanced when $C_2 = \frac{R_1 C_1}{R_2}$ if R-7 = 0. If the capacitor being checked does not have a power factor of zero, then it is necessary to introduce an equivalent resistance in series with C_1 to obtain balance. Resistor R-7 can be calibrated by use of the following formula:

$$\text{P.F. in \%} = \frac{\text{R-7}}{\sqrt{(\text{R-7})^2 + (X_{c1})^2}} \times 100$$

The purpose of S-8 is to short out the minimum resistance of R-7 when checking paper or mica condensers.

SECTION III

INSTALLATION AND INITIAL ADJUSTMENTS

1. INSTALLATION

A. The Model 976 is shipped from the factory ready for immediate use, (see Figure 11). Place the instrument on a sturdy bench or table within six feet of a 105-125 volt A.C., 50-60 cycle outlet.

B. Open the cover, take out the line cord and plug it into an AC outlet.

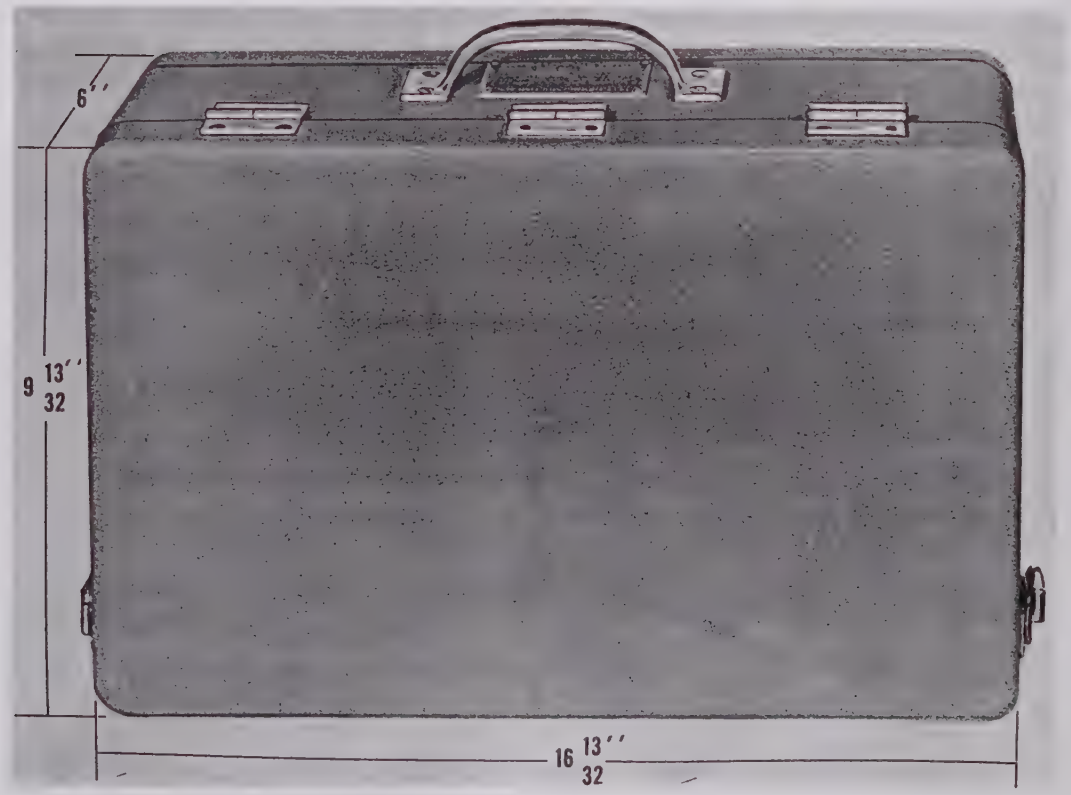


Figure 11. Model 976 with Cover Closed

2. INITIAL ADJUSTMENTS

A. Before making any test, make sure that the meter pointer rests on zero of the scale plate. If the pointer is off zero, mechanically adjust the pointer by turning the screw in the bottom center of the meter case with a screwdriver. The Model 976 is now ready for operation.

B. Snap the POWER toggle switch to the ON position and the pilot lamp should light. If it does not, examine the lamp and the line fuse in the panel assembly.

SECTION IV

OPERATION

1. GENERAL

A. CONNECTIONS

At the right hand edge of the panel there are three jacks arranged vertically, (see Figure 12). The top banana jack is used only with the high voltage multiplier probe. The other two pin jacks are used with the following functions: A.C. VOLTS, 1200 VOLTS A.C., D.C. VOLTS NORMAL, D.C. VOLTS REVERSE, OHMS, and D.C. MILLIAMPERES. For measurement of A.C. VOLTS and 1200 VOLTS A.C. the R.F. PROBE must be plugged into the probe well on the panel.

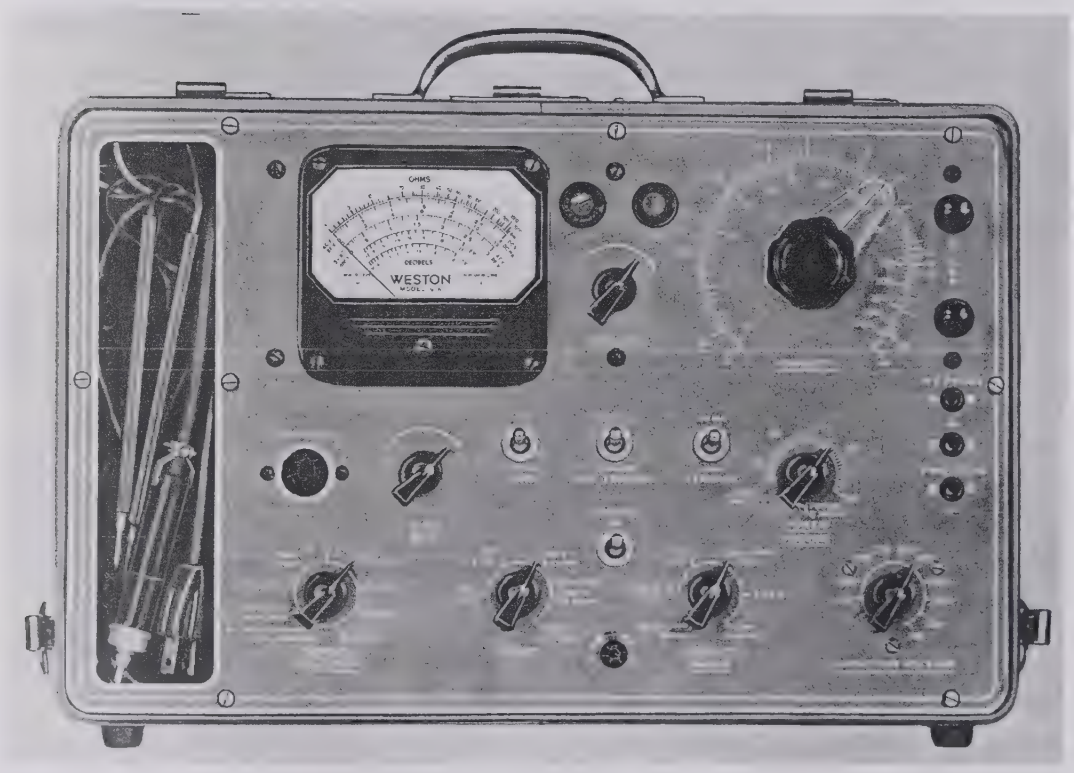


Figure 12. Model 976 Front Panel

Two binding posts are provided on the panel for connecting capacitors when measuring capacitance and leakage current.

The R.F. probe is used for measurement of R.F. VOLTS and PEAK R.F. VOLTS, (see paragraph 2).

B. SUPPLY VOLTAGE

For all measurements, except D.C. current the instrument must be connected to a 105 to 125 volt 50 to 60 cycle line.

2. A.C. AND R.F. MEASUREMENTS

A. A.C. VOLTS TO 300 VOLTS

When measuring A.C. volts from 20 to 50,000 cycles plug the probe into the probe well, and use the two pin jacks for connecting the test leads. Input capacitance is 150 mmfd.

B. 1200 VOLTS A.C.

Same as A.C. VOLTS except that an added input resistance divider of 15 megohms is used.

C. R.F. VOLTS

When measuring R.F. VOLTS from 3000 cycles to 300 megacycles remove probe from well and make connections between center tip and metal ferrule on the R.F. probe. Keep leads as short as possible, removing the screw tip from the probe will help at the higher frequencies. Input capacitance is 5.5 mmfd. For frequencies above 150 megacycles, the actual value of the voltage being measured is computed by multiplying the meter reading by the percentage shown in Figure 13. For instance, at 300 megacycles the actual value is only 84 percent of the indicated value.

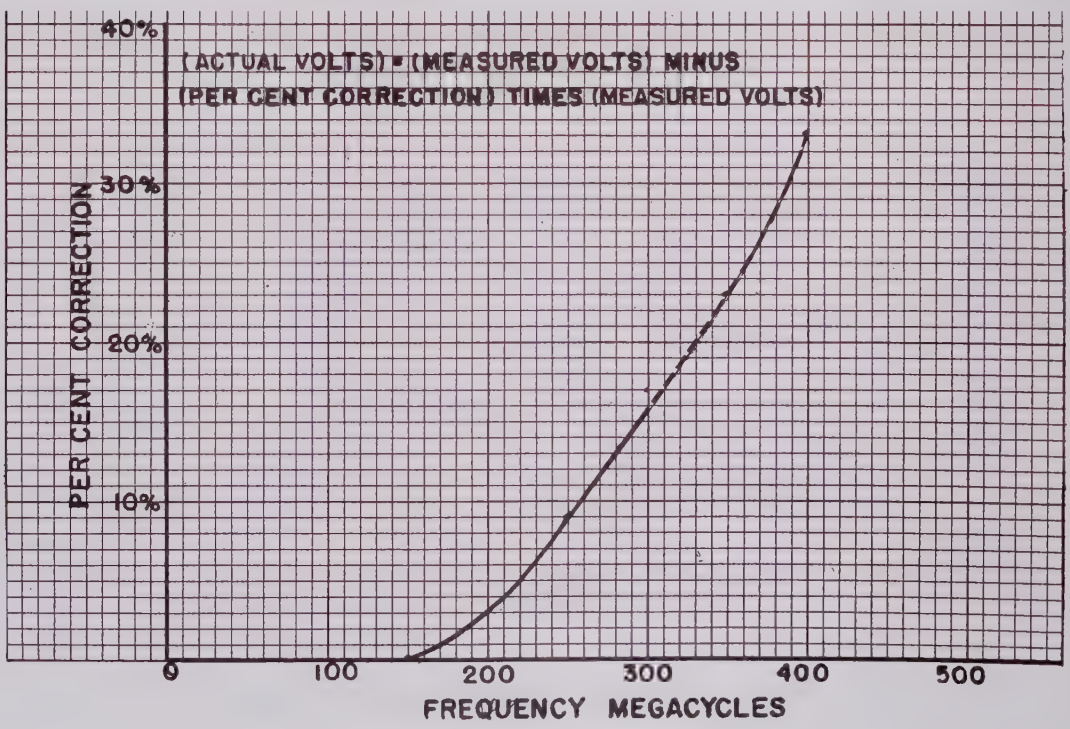


Figure 13. Frequency Correction Curve for R.F. Probe

For frequency range of 60 cycles to 50,000 cycles, the capacitor adapter should be added. The input capacitance is less than 10 mmfd.

D. PEAK R.F. VOLTS

Same as R.F. VOLTS except meter reads peak value.

E. MAXIMUM VOLTAGE RATING

Do not apply more than 300 volts a-c to the probe. Do not apply more than 500 volts d-c to the probe. Do not apply a combination of a-c and d-c in excess of 500 volts (d-c plus peak a-c).

F. CHOICE OF A.C. AND R.F. CONNECTIONS

For information concerning A.C. and R.F. connections see Table I.

TABLE I

CHOICE OF A.C. AND R.F. CONNECTIONS

FUNCTION	CONNECT SIGNAL TO	CONNECT GROUND TO	NOTE	FREQ. RANGE
A.C. VOLTS	+ Pin Jack	- Pin Jack	R.F. Probe in well	20-50,000Mc.
R.F. VOLTS	Probe tip	- Pin Jack		3000-5Mc.
R.F. VOLTS	Probe tip	Ground clip lead (W-5)		3000-50Mc.
R.F. VOLTS	Probe tip	Probe ferrule		3000-150Mc.
R.F. VOLTS	Probe less tip	Probe ferrule	See par. 2c	150-300Mc.
PEAK R.F. VOLTS	Capacitor Adaptor tip (C-14)	- Pin Jack		60-50,000Mc.
PEAK R.F. VOLTS	Probe tip	- Pin Jack		3000-5Mc.
PEAK R.F. VOLTS	Probe tip	Ground clip lead (W-5)		3000-50Mc.
PEAK R.F. VOLTS	Probe tip	Probe ferrule		3000-150Mc.
PEAK R.F. VOLTS	Probe less tip	Probe ferrule	See par. 2c	150Mc-300Mc.

3. STEP BY STEP OPERATING INSTRUCTIONS

NOTE 1

Keep CAPACITOR VOLTAGE control set to zero when not in use.

A. D.C. VOLTS

1. Connect line cord to power line, and snap POWER toggle switch to the ON position.
2. Set CAPACITY RANGE switch to VTVM.
3. Set CIRCUIT SELECTOR switch to D.C. VOLTS NORM., CAP LEAKAGE.

4. Set RANGE switch to 1200 V.

5. Adjust ZERO SET control until meter pointer lines up with ZERO at LEFT end of scale. Be sure that ZERO toggle switch is in LEFT position.

6. Plug BLACK test leads in NEGATIVE jack.

7. Plug RED test leads in POSITIVE jack.

8. Connect TEST LEADS to circuit, always placing BLACK-NEGATIVE lead on ground side of circuit being tested.

9. Reset RANGE switch for best reading on BLACK DCV arc. For low voltage ranges reset to zero with the test leads shorted together.

B. D.C. VOLTS REVERSE

1. Same procedure as D.C. VOLTS, except that CIRCUIT SELECTOR switch is set to D.C. VOLTS REVERSE. This range is used for measuring d-c volts negative with respect to ground. The NEGATIVE-BLACK lead should always be connected to ground side of circuit.

2. ZERO CENTER may be set for use in discriminator alignment by setting ZERO toggle to the CENTER position and adjusting the ZERO SET control until the pointer reads mid-scale. Readings to the left are positive and readings to the right are negative.

C. H.V. D.C. PROBE

1. Connect line cord to power line, and snap POWER toggle switch to ON position.

2. Set CAPACITY RANGE switch to VTVM.

3. Set CIRCUIT SELECTOR switch to D.C. VOLTS NORMAL for positive voltages, or to D.C. VOLTS REVERSE for negative voltages.

4. Set RANGE switch to 300 volts for the 12,000 volt range.

5. Adjust ZERO SET control until meter pointer lines up with ZERO at LEFT end of scale. Be sure that ZERO toggle switch is in LEFT position.

6. Ground ALLIGATOR CLIP A (figure 6) to chassis of device on which high voltages are to be measured.

7. Plug ELBOW terminal B (figure 6) in NEGATIVE pin jack.

8. Plug BANANA plug C (figure 6) in H.V. PROBE jack.

9. Touch end of H.V. PROBE to H.V. point being measured and read voltage on BLACK DCV arc.

CAUTION: HOLD THE PROBE BY MEANS OF THE BLACK HANDLE. DO NOT LET FINGERS SLIP PAST THE GROUNDING SHIELD ONTO THE RED INSULATOR.

SAFETY FIRST

10. The probe may be used on lower ranges when a high input resistance of 600 megohms is desired. The probe multiplying factor is 40, so that the following ranges can be used.

DIRECT		PROBE	
3 v	-	120 v	
12 v	-	480 v	
30 v	-	1200 v	
120 v	-	4800 v	
300 v	-	12,000 v	
1200 v	-	48,000 v	DO NOT EXCEED 30,000 v.

D. A.C. VOLTS

1. Connect line cord to power line, and snap POWER toggle switch to the ON position.
2. Set CAPACITY RANGE switch to VTVM.
3. Set CIRCUIT SELECTOR switch to A.C. VOLTS.
4. Plug R.F. PROBE into the probe well.
5. Set RANGE switch to 300 volts.
6. Adjust ZERO SET control until meter pointer lines up with ZERO at LEFT end of scale. Be sure that the ZERO toggle is set to the LEFT position.
7. Plug BLACK test lead in NEGATIVE jack.
8. Plug RED test lead in POSITIVE jack.
9. Connect test leads to circuit, always placing NEGATIVE-BLACK lead on ground side of circuit being tested.
10. Reset RANGE switch for best reading and for low voltage ranges reset to zero with test leads shorted together.
11. Read meter on BLACK DCV arc except for the 3 volt range which is read on the RED ACV arc.

E. 1200 VOLTS A.C.

SAFETY FIRST

1. Connect line cord to power line and snap POWER toggle switch to the ON position.
2. Set CAPACITY RANGE switch to VTVM.
3. Set CIRCUIT SELECTOR switch to 1200 VOLTS A.C.

NOTE 2

In switching to 1200 V A.C. the instrument pointer may swing momentarily over top mark if previously used on A.C. VOLTS.

SAFETY FIRST

4. Plug R. F. PROBE into the probe well.
5. Set RANGE switch to 1200 V.
6. Adjust ZERO SET control until meter pointer lines up with ZERO at LEFT end of scale. Be sure that the ZERO toggle is in the LEFT position.
7. Plug BLACK test lead in NEGATIVE pin jack.
8. Plug RED test lead in POSITIVE pin jack.
9. Connect test leads to circuits, always placing NEGATIVE-BLACK lead on GROUND side of circuit being tested.
10. Read meter on BLACK DCV arc.
11. For maximum safety when measuring high voltage or when measuring between two points, neither of which is on ground, use the following procedure:
    a. De-energize the equipment to be tested.
    b. Set the multimeter in a vertical position so that it rests on its rubber feet.
    c. Connect the test leads.
    d. Energize the equipment to be tested and note the reading on the multimeter without coming into contact with the metal case.

F. DECIBELS

1. Operate same as A. C. VOLTS.
2. Read the scale indicated in Table II. One milliwatt in 600 ohms equals zero DB.

TABLE II

DECIBEL CORRECTION TABLE

Range	Read DB arc	Add
3 v	Red	0 db.
12 v	Black	0 db.
30 v	Black	+8 db.
120 v	Black	+20 db.
300 v	Black	+28 db.
1200 v	Black	+40 db. (Use 1200v A.C. position)

G. R. F. VOLTS

1. Connect line cord to power line and snap POWER toggle to the ON position.
2. Set CAPACITY RANGE switch to VTVM.
3. Set CIRCUIT SELECTOR switch to R. F. VOLTS.
4. Set RANGE switch to 300 volts.

5. Adjust ZERO SET control until meter pointer lines up with ZERO at left END of scale. Be sure that the ZERO toggle is in the LEFT position.

6. Apply tip of R. F. PROBE to measuring point directly using the short clip lead for a grounding wire. (See Section II - R. F. PROBE for voltage and frequency ratings.)

7. Reset RANGE switch for best reading and for low voltages reset zero with probe tip applied to ground.

8. Read meter on BLACK DCV arc for all ranges except the 3 volt range which is read on the RED ACV arc.

H. PEAK R. F. VOLTS

1. Same as R. F. VOLTS except for step 3 set CIRCUIT SELECTOR to PEAK R. F. VOLTS.

2. PEAK A. C. VOLTS may be measured using capacitor adapter, (See paragraph 2).

I. D. C. MILLIAMPERES

1. Set CIRCUIT SELECTOR switch to DC MA.

2. Set CAPACITY RANGE switch to VTVM.

3. Set RANGE switch to 1200 V (1200 MA) position.

4. Plug BLACK test lead in NEGATIVE jack.

5. Plug RED test lead in POSITIVE jack.

6. Connect test leads to circuit, observing proper polarity.

7. Reset RANGE switch for best reading on BLACK DC MA arc.

8. Read the BLACK DC MA arc using a range in milliampere corresponding to setting of RANGE switch in VOLTS.

NOTE 3

For DC MA. the instrument may be operated without being connected to a power line, and that since this circuit is not electronic it has no overload protection.

J. OHMS.

1. Connect line cord to power line, and snap POWER toggle switch to the ON position.

2. Set CAPACITOR RANGE switch to VTVM.

3. Set CIRCUIT SELECTOR switch to OHMS.

4. Set RANGE switch in accordance with Table III.

SAFETY FIRST

TABLE III

RESISTANCE RANGE SELECTION

Use Range	For Resistance Values
R x 1	0 - 100 ohms
R x 10	100 - 1000 ohms
R x 100	1000 - 10,000 ohms
R x 1000	10,000 - 100,000 ohms
R x 10,000	100,000 - 2 Megohms
R x 1 Megohm	2 - 2000 Megohms

5. Plug BLACK test lead in NEGATIVE jack.

6. Plug RED test lead in POSITIVE jack.

7. Short test leads together and adjust ZERO SET control until meter pointer lines up with ZERO at LEFT end of scale. Be sure the ZERO toggle is in the LEFT position.

8. Open test leads and adjust meter pointer to top mark by means of OHM ADJ.

9. Apply test leads to resistor being measured and read on OHMS arc. Note that the circuit under test must be de-energized when measuring resistance.

K. ELECTROLYTIC CAPACITOR LEAKAGE

1. Connect line cord to power line and snap POWER toggle to ON position.

SAFETY FIRST

2. Set CAPACITOR VOLTAGE control to 0 volts.

* * * * WARNING * * * *

Severe electrical shock may result if improperly used.

3. Set CIRCUIT SELECTOR to D.C. VOLTS NORM., CAP LEAKAGE.

4. Set CAPACITY RANGE switch to CAP LEAKAGE.

5. Set RANGE switch according to the rated working voltage of the capacitor to be tested.

6. Adjust ZERO SET control so meter pointer lines up with ZERO at LEFT end of scale. Be sure ZERO toggle is in LEFT position.

7. Connect capacitor across binding posts noting polarity.

CAUTION

Incorrect polarity will damage the capacitor, or burn out the 1/32 ampere fuse and make the circuit inoperative.

8. Pull the CAP. LEAKAGE toggle to the LEAKAGE position then advance CAPACITOR VOLTAGE control toward the rated working voltage of the

SAFETY FIRST

capacitor noting that the current must never exceed 10 milliamperes. If a steady (10 to 15 minutes) reading in excess of 10 milliamperes is obtained, the capacitor should be discarded without applying full rated voltage.

9. Release the CAP. LEAKAGE toggle and reset the CAPACITOR VOLTAGE control until the meter reads the rated working voltage exactly.

10. Pull the CAP. LEAKAGE toggle again to the LEAKAGE position and read the leakage current. If the current is less than 3 milliamperes pull the LEAKAGE toggle to the 3 MA position.

11. The leakage current should not exceed the value of I in the formula:

$$I = KC + 0.3$$

where I is the d-c leakage in milliamperes
C is the rated capacitance in microfarads
K is a constant from Table IV

TABLE IV

Rated Working Voltage	K
15 to 100	0.01
101 to 250	0.02
251 to 350	0.025
351 to 450	0.04

NOTE 4

For electrolytic capacitors which have been in stock or have not been in use for several months, a warming period of 30 minutes should be allowed.

12. Slowly return the CAPACITOR VOLTAGE control to 0 volts to discharge the capacitor under test. Then the capacitor may safely be disconnected.

CAUTION

When large capacitors (greater than 1 watt second) are under test a rapid rotation of the CAPACITOR VOLTAGE control in either direction, is apt to burn out the 1/32 ampere fuse.

L. CAPACITY TEST

1. Connect line cord to power line and snap POWER toggle to ON position.

2. Turn CAPACITOR VOLTAGE control to 0 volts.

3. Plug R.F. PROBE in R.F. probe well.

4. Set CAPACITY RANGE switch to VTVM.

5. Set CIRCUIT SELECTOR to CAPACITY.

6. Set RANGE switch to 3 V.

7. Adjust ZERO SET control so meter pointer lines up with ZERO at LEFT end of scale. Be sure ZERO toggle is set to LEFT position.

8. Set POWER FACTOR control to PAPER & MICA.

9. Connect capacitor to binding posts.

10. Set RANGE switch to 30 V.

11. Set CAPACITY RANGE switch to an appropriate range.

12. Adjust CAPACITY control for minimum deflection on the meter, setting RANGE switch to 3 volts for the final minimum reading.

13. Read OUTER ARC of CAPACITY scale except for the 26 to 1000 microfarad range.

14. For electrolytic capacitors, rotate POWER FACTOR control also to obtain minimum deflection and read % POWER FACTOR on POWER FACTOR scale.

15. A shorted capacitor will give a reading of infinity.

16. An open capacitor will give a reading much lower than the rated value.

17. For low values of capacitance (200 mmf or less) subtract from the reading the value of stray capacitance which may be measured by adjusting the bridge for balance with the capacitor disconnected. The stray capacitance is approximately 10 microfarads without test leads and about 40 mmf with test leads.

4. PRECAUTIONS

A. AGAINST HARM TO OPERATOR AND INSTRUMENT

1. Do not plug the Model 976 into a DC line. Be sure the power line to be used operates at a potential of 105-125 volts 50-60 cycles.

2. Use the H.V. Probe intelligently by following the safety precautions outlined in Section II, paragraph 4.

3. When using D.C. Milliamperes be sure that the RANGE switch is set to the highest milliamperes range when meter is connected into the circuit.

B. AGAINST FAULTY READINGS AND MISINTERPRETATION

1. Be sure to read the correct scale.

2. Understand the divisions on each scale.

3. Be sure that the step-by-step instructions have been followed correctly.

SECTION V

PREVENTIVE MAINTENANCE

1. H.V. PROBE INSPECTION

Check the solder connections at points A, B and C indicated in figure 5 before using the probe for high-voltage measurements. The use of this probe can be dangerous unless these connections are securely soldered.

2. FUSES

If a fuse is burned out, replace it with one having the same ampere value. Occasionally the fuseholder connections or the end caps of the fuse itself may be found corroded. Use ammonia to remove any corrosion from the holder connections and install a new fuse.

3. BATTERY INSPECTION

To check the battery in this equipment set the RANGE switch to the R x 1 position and see if full scale deflection can be obtained by rotating the ZERO ADJ knob. Test leads should not be shorted to obtain top mark. Failure to reach this point indicates a weak battery which should be replaced.

4. STORING THE INSTRUMENT

If the Model 976 is to be put in storage for six months or more, remove the battery. Failure to do this may result in damage to the instrument. Batteries expand with age and may split open and release corrosive chemicals.

5. FUNGUS PROOFING

If this instrument is to be fungus proofed, keep the protective material away from switches. Failure to take this precaution will ruin the switches and necessitate replacing them.

SECTION VI

CORRECTIVE MAINTENANCE

1. TROUBLE SHOOTING NOTES

The chart on page 24 should be used as a guide to find the troubles that may arise within this instrument. Before making use of this chart the trouble shooter should make a physical inspection of the device to check for charred components or broken connections. Often the trouble can be determined immediately in this manner.

This chart is progressively dependent since the blocks that follow others are for the most part non-repetitive of the others. For example, if there is trouble concerned with the DC VOLTS NORMAL circuit (block #21), then the circuits represented by blocks #1 to #20 inclusive must be in working order before the trouble shooter proceeds.

In several blocks of the chart, references are made to specific paragraphs which start with 2A below. These paragraphs should be read thoroughly and any instructions contained there-in followed carefully.

2. ADJUSTMENTS

Four controls have been provided for calibrating this instrument. The accuracies of the instrument depend upon the accuracy of the test voltages applied. The Electronic Multimeter should be warmed up for at least 15 minutes before any of the four following adjustments are made.

A. Set the CIRCUIT SELECTOR switch to DC VOLTS NORMAL, the RANGE switch to 12 V and connect the test leads to 12 volts DC. Referring to figure ~~16~~ 17, page ~~46~~ 47, adjust R-46B for an exact full-scale meter indication.

B. Set the CIRCUIT SELECTOR switch to DC VOLTS REVERSE, set the RANGE switch to 12 V, and with a negative 12 volts DC applied, adjust R-46A for an exact full-scale meter indication.

C. Set the CIRCUIT SELECTOR switch to AC VOLTS, set the RANGE switch to 12 V and apply 12 volts AC. The RF Probe must be placed in the RF Probe Well. Adjust R-50A for an exact full-scale meter indication. This adjustment takes care of AC VOLTS, 1200 V AC and RF VOLTS.

D. Set the CIRCUIT SELECTOR switch to PEAK RF VOLTS, the RANGE switch to 12 V and apply 8.48 volts AC between the negative pin jack and the end of C-6 which is connected to the common terminal on deck 3A of S-7. Adjust R-50B for an exact full-scale meter indication. For this adjustment the probe must be in the probe well.

3. ADDITIONAL TROUBLE SHOOTING CHART CROSS REFERENCE

A. The milliammeter section of this instrument must function properly before any other section can be checked. To check spools R-8 through R-13, set the CIRCUIT SELECTOR switch to DC VOLTS REVERSE and with a Wheatstone bridge measure the resistance of each spool. The resistance of these spools is so low that it can be measured accurately only by using heavy test leads firmly connected or temporarily soldered to the spool under test.

B. If 1.5 volts produces a full-scale meter indication on one or more ranges and if there is no indication on one or more of the higher ranges, then one of the resistors between R-14 and R-20 is opened. If different errors are obtained on different ranges, then it will be necessary to accurately check all resistors (R-14 through R-20). To do this, disconnect the AC cord from the power line and remove instrument from case. Set the SELECTOR switch to DC VOLTS REVERSE and connect the leads from a Wheatstone bridge to the NEGATIVE pin jack and the center shield pin of socket XV-2. Check R-20 by setting the RANGE switch to 1200 V. Check R-19 + R-20 by setting the RANGE switch to 300 V. Check R-18 + R-19 + R-20 by setting the RANGE switch to 120 V. Continue this step-by-step procedure until the defective spool or spools have been located.

C. If R-6 must be replaced or if the knob has been removed from the shaft, it will be necessary to readjust the knob setting with respect to the engraving on the panel. Proper procedure for doing this is as follows:

1. Disconnect the two leads going to the outside terminals on the control.
2. With the knob removed and the control tightened to the panel so that it cannot move, rotate the shaft until the resistance between the center terminal and each outside terminal is equal.

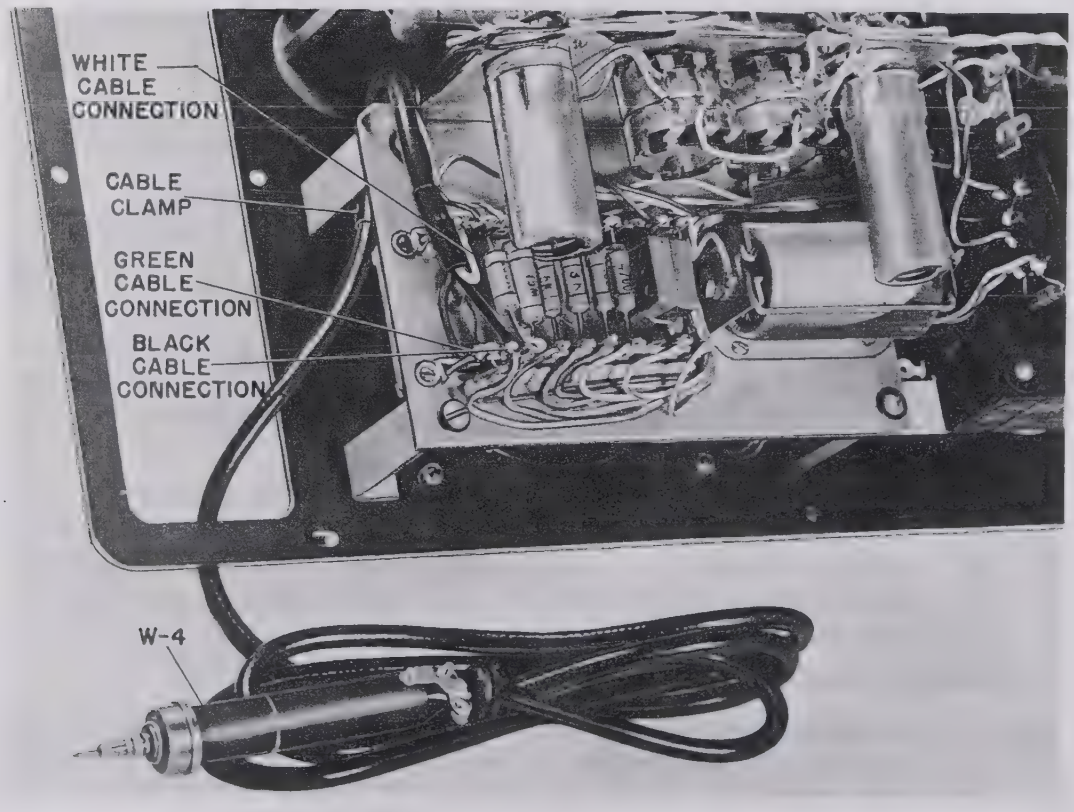


Figure 14. RF Probe Chassis Connections

3. Place the knob on the shaft and tighten with the index line pointing to 2 on the low capacitance range arc.

D. If it becomes necessary to replace R-7, rotate the shaft of the control in a clockwise direction until the shorting switch on the back clicks open. The resistance between the center terminal and the outside terminal should equal zero. If it does not, set the control in the following manner: Continue to rotate the shaft of the control in the clockwise direction until some resistance is obtained and then rotate it in the counterclockwise direction until the resistance is exactly zero. At this point, the knob should be indexed to zero and tightened on the shaft.

E. If components of the RF Probe are found to be defective, the entire probe assembly, including the cable, should be sent to the Weston Electrical Instrument Corporation for repair.

To disconnect the RF Probe from the chassis, refer to figure 14 and follow the few simple instructions given below:

1. Unsolder the ~~red~~ black, white and green leads from the soldering lugs on the sub-chassis, (see Figure 14).

2. Loosen the cable clamp that holds the probe cable to the underside of the panel and pull cable free.

3. To reconnect the probe, reverse the procedure making sure to place the cable exactly as shown in figure 14.

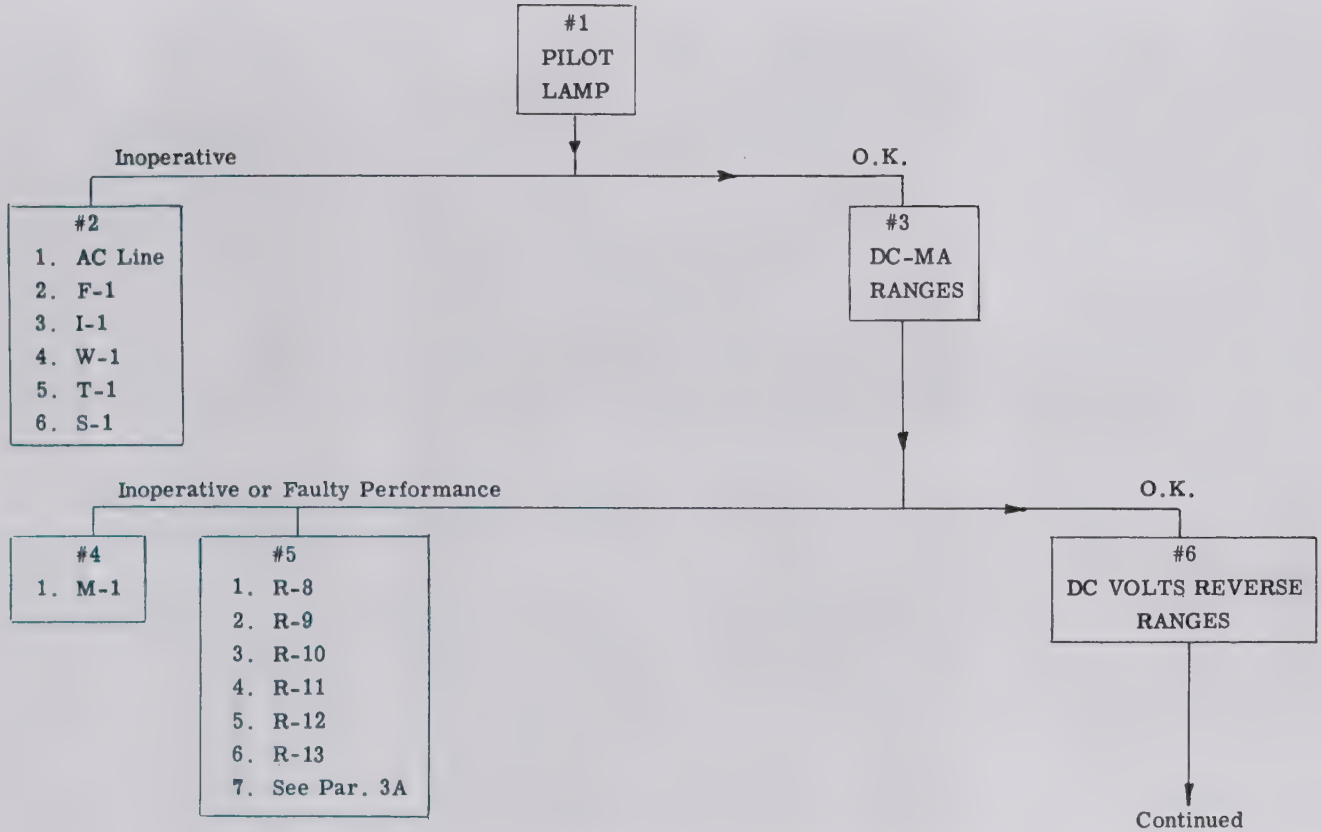
4. VOLTAGE

A. Voltage across C-1 should measure between 480 and 600 v DC.

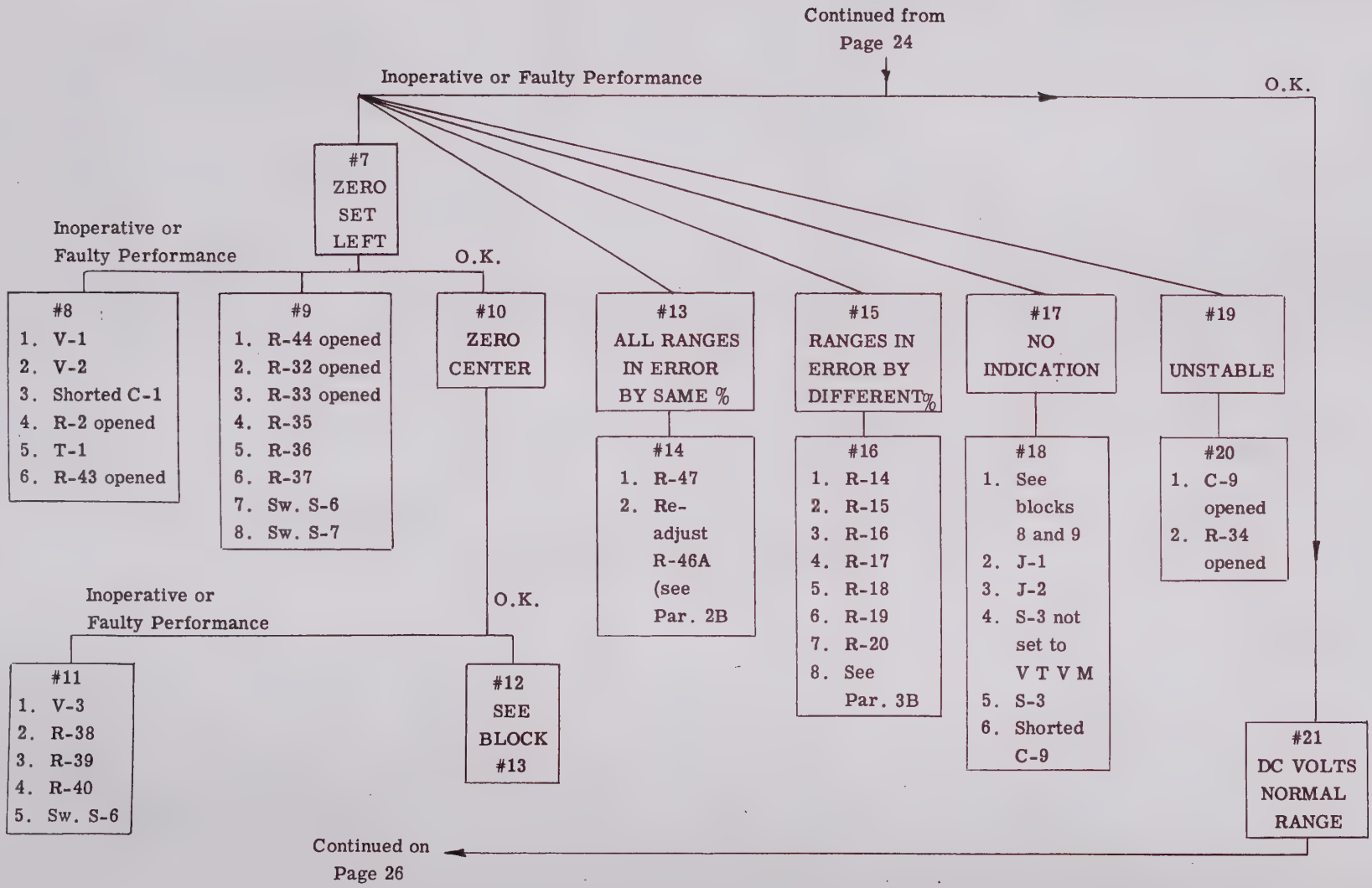
B. Voltage from the junction of R-32 and R-33 to ground should measure 130 v DC.

TABLE 4

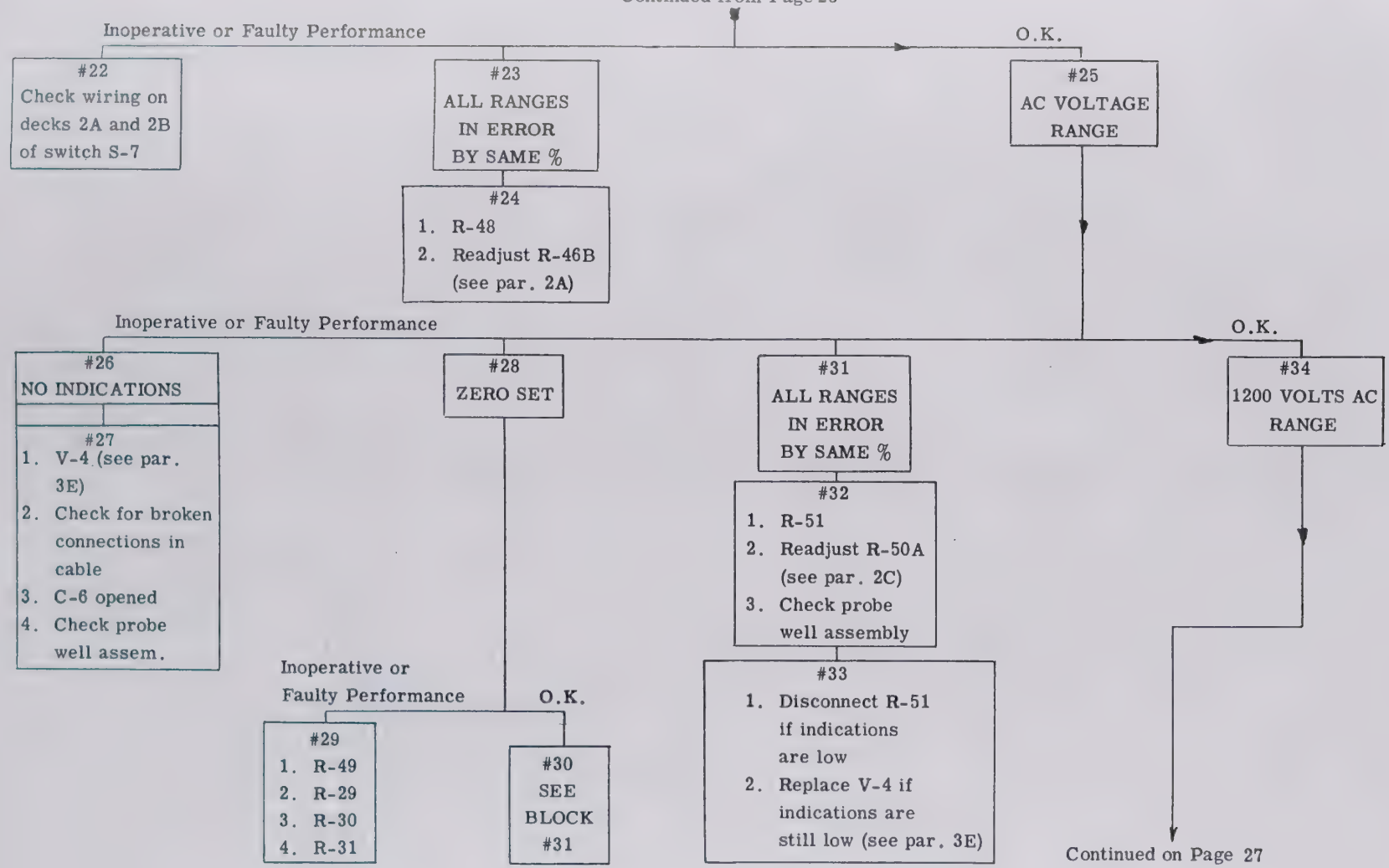
TROUBLE SHOOTING CHART



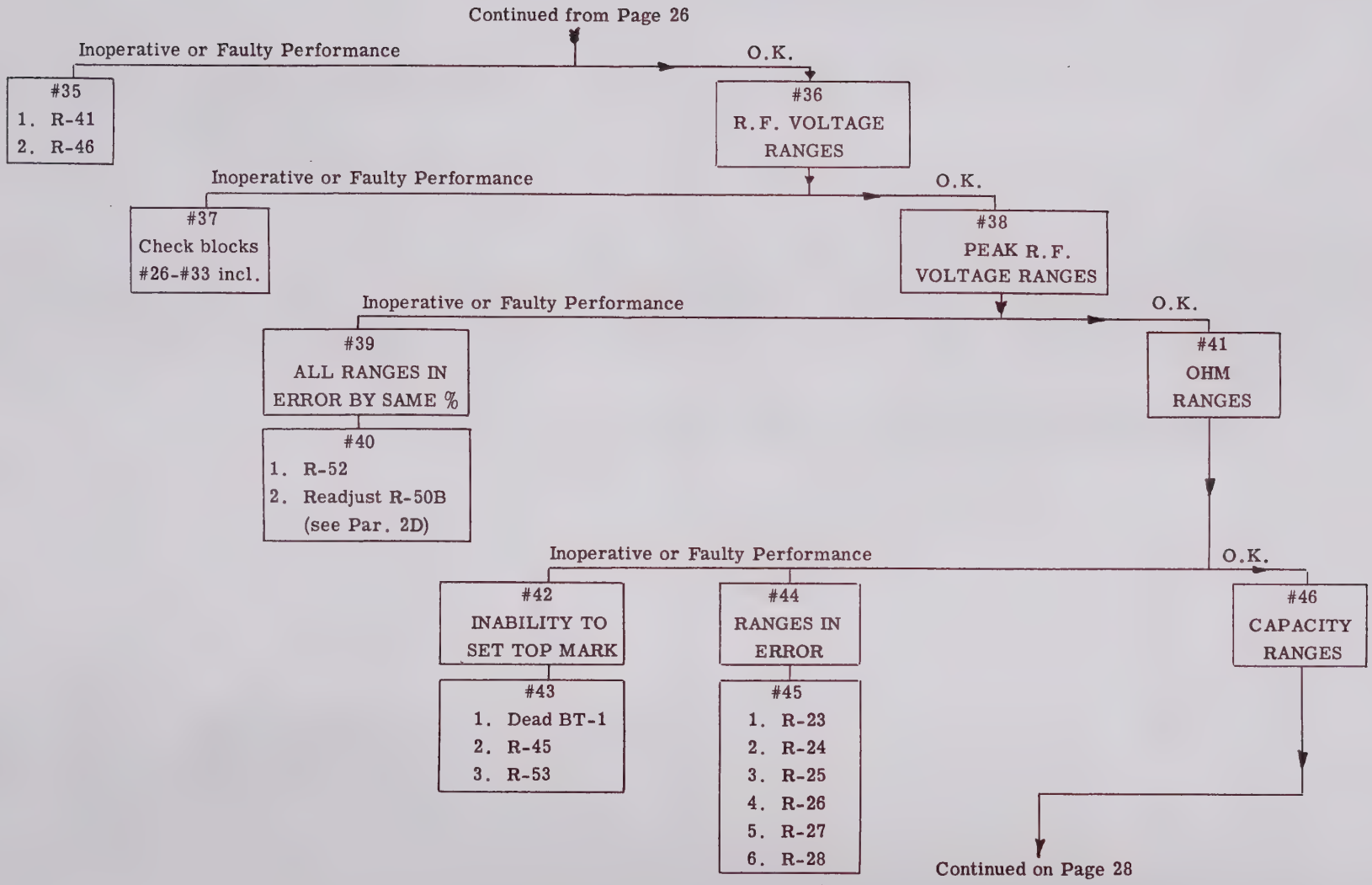
Continued
Page 25


Continued from Page 24
Inoperative or Faulty Performance
O.K.
#7 ZERO SET LEFT
Inoperative or Faulty Performance
O.K.
#8
1. V-1
2. V-2
3. Shorted C-1
4. R-2 opened
5. T-1
6. R-43 opened
#9
1. R-44 opened
2. R-32 opened
3. R-33 opened
4. R-35
5. R-36
6. R-37
7. Sw. S-6
8. Sw. S-7
#10 ZERO CENTER
#13 ALL RANGES IN ERROR BY SAME %
#14
1. R-47
2. Re-adjust R-46A (see Par. 2B
#15 RANGES IN ERROR BY DIFFERENT%
#16
1. R-14
2. R-15
3. R-16
4. R-17
5. R-18
6. R-19
7. R-20
8. See Par. 3B
#17 NO INDICATION
#18
1. See blocks 8 and 9
2. J-1
3. J-2
4. S-3 not set to V T V M
5. S-3
6. Shorted C-9
#19 UNSTABLE
#20
1. C-9 opened
2. R-34 opened
Inoperative or Faulty Performance
O.K.
#11
1. V-3
2. R-38
3. R-39
4. R-40
5. Sw. S-6
#12 SEE BLOCK #13
#21 DC VOLTS NORMAL RANGE
Continued on Page 26

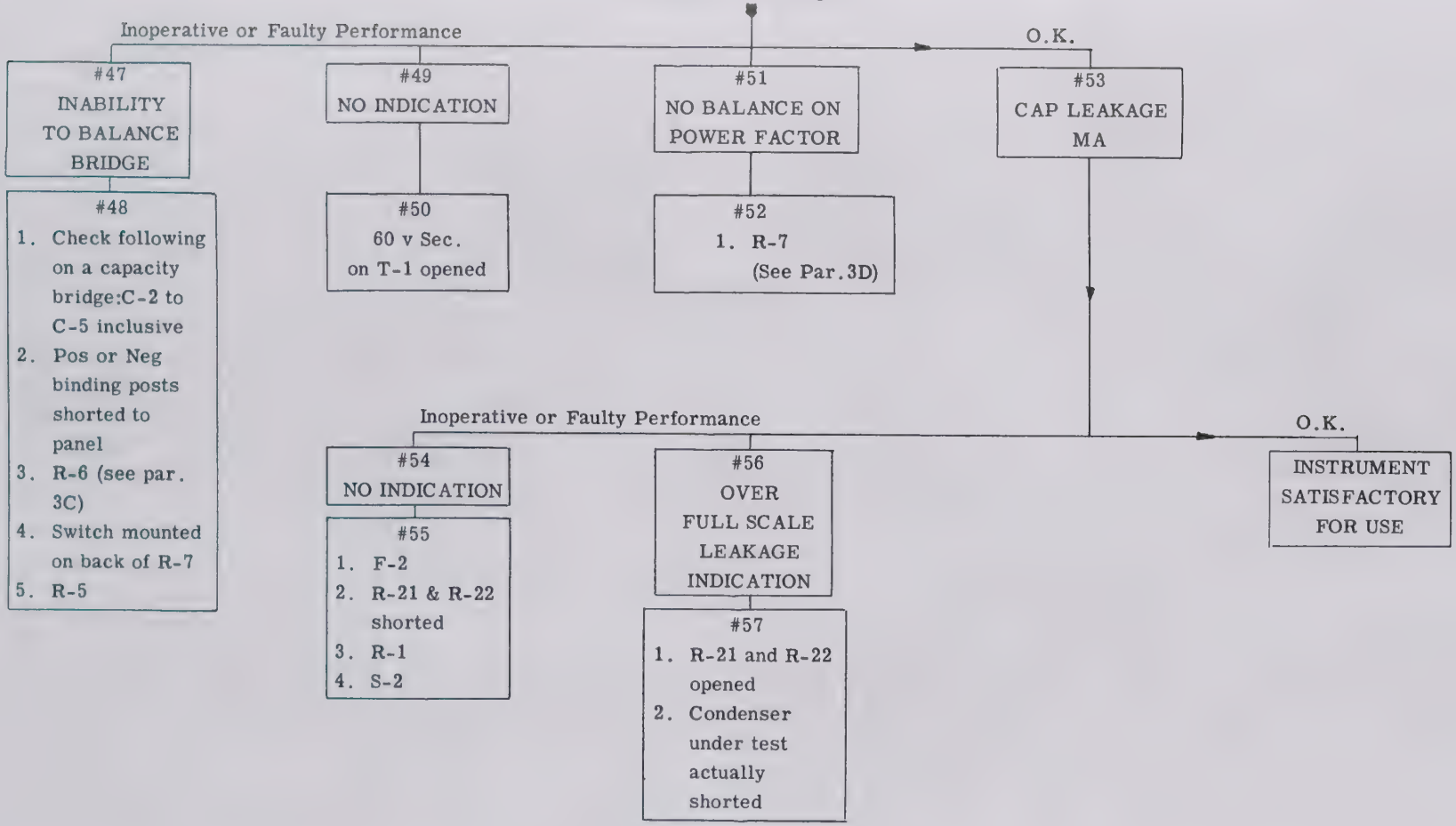
Continued from Page 25

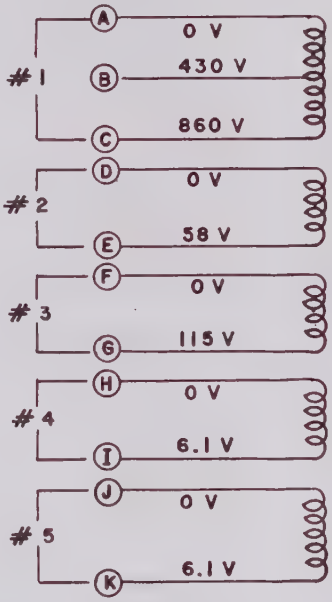


Continued on Page 27


Continued from Page 26
Inoperative or Faulty Performance
O.K.
#35
1. R-41
2. R-46
#36
R.F. VOLTAGE RANGES
Inoperative or Faulty Performance
O.K.
#37
Check blocks #26-#33 incl.
#38
PEAK R.F. VOLTAGE RANGES
Inoperative or Faulty Performance
O.K.
#39
ALL RANGES IN ERROR BY SAME %
#40
1. R-52
2. Readjust R-50B (see Par. 2D)
#41
OHM RANGES
Inoperative or Faulty Performance
O.K.
#42
INABILITY TO SET TOP MARK
#43
1. Dead BT-1
2. R-45
3. R-53
#44
RANGES IN ERROR
#45
1. R-23
2. R-24
3. R-25
4. R-26
5. R-27
6. R-28
#46
CAPACITY RANGES
Continued on Page 28

Continued from Page 27



DESIG-NATION SYMBOL	DIAGRAM	WINDING	WIRE SIZE	TURNS	DC RESISTANCE IN OHMS
T-1		1-A TO B 1-A TO C	NO.34 NO.34	1836 3672	239 478
		2-D TO E	NO.33	248	29.8
		3-F TO G	NO.24	491	7.3
		4-H TO I	NO.22	26	
		5-J TO K	NO.20	26	

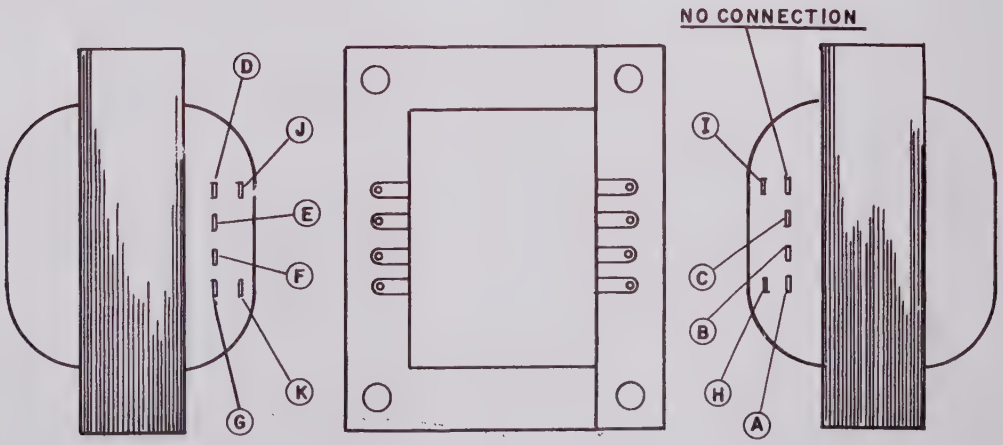


Table 6. Winding Data

SECTION VII

PARTS LIST

CIRCUIT SYMBOL	NAME OF COMPONENT AND DESCRIPTION	MANU-FACTURER	MANUFAC-TURER'S PART NUMBER	JAN OR NAME TYPE DESIGNATION	ALL SYMBOL DESIGNATIONS INVOLVED
	CAPACITORS				
C-1	CAPACITOR, FIXED, PAPER: 2 mfd; +20% -10%; 600 vdcw; drawn metal shell; Dykanol filled.	8	DYR 6200		C-1
C-2	CAPACITOR, FIXED, PAPER: 2 mfd; ±1%; 600 vdcw; drawn metal shell; Dykanol filled.	8	DYR 6200		C-2
C-3	CAPACITOR, FIXED, MICA; .02 mfd; ±1%; Parallel matched using- (2-.01 mfd capacitors); 300 vdcw; Case brown moulded bakelite.	1	1467		C-3
C-4	CAPACITOR, FIXED, CERAMIC: 130 mmfd; ±5%; 500 vdcw; zero temperature coefficient compensating type; Durez coated.	5	TCE-130		C-4
C-5	CAPACITOR, ADJUSTABLE, CERAMIC: 12-62 mmfd; trimmer; 500 vdcw; zero temperature coefficient compensating type.	5	823AZ		C-5
C-6	CAPACITOR, FIXED, PAPER: .05 mfd; ±20%; 600 vdcw; moulded in tubular plastic case; wax impregnated.	20	Type 30		C-6
C-7	CAPACITOR, FIXED, CERAMIC: .01 mfd; ±20%; 400 vdcw.	11	811		C-7
C-8	CAPACITOR, FIXED, CERAMIC: 1000 mmfd min.; 500 vdcw; durez coated.	5	GMV-DO-20A		C-8, C-12, C-13

CIRCUIT SYMBOL	NAME OF COMPONENT AND DESCRIPTION	MANU-FACTURER	MANUFAC-TURER'S PART NUMBER	JAN OR NAME TYPE DESIGNATION	ALL SYMBOL DESIGNATIONS INVOLVED
	CAPACITORS (Cont)				
C-9	CAPACITOR, FIXED, MICA: .005 mfd; ±10%; 300 vdcw; low loss bakelite.	8	1WL		C-9
C-10	CAPACITOR, FIXED, MICA: 500 mmfd; ±10%; 500 vdcw; button type; without eyelet, terminals or color code, 1250 vdc flash test, p/o W-4.	11	Type 37-BM		C-10
C-11	CAPACITOR, FIXED, MICA: .005 mfd; ±10%; 1200 vdcw; moulded in bakelite.	1	1456L		C-11
C-12	Same as C-8.				
C-13	Same as C-8.				
C-14	CAPACITOR, FIXED, PAPER: .01 mfd; ±20%; 400 vdcw.	8	ZY4SI		C-14
	MISCELLANEOUS ELECTRICAL PARTS				
E-1	BATTERY CLAMP: 2-3/4" lg; 7/8" wide; 1-1/2" high one end; 1-3/8" high other end; adjustable metal contact on each end.	21	118817		E-1
E-2	CAP, TEST TERMINAL: black bakelite; 0.49" lg; 0.50" OD top; 0.449" OD bottom; No. 10-32 thd; 90° knurled.	21	121980		E-2, E-3
E-3	Same as E-2.				
	FUSES				
F-1	FUSE: 1 amp; 8 AG; auto type; size 1/4" x 1".	15	Cat. No. 362001		F-1

CIRCUIT SYMBOL	NAME OF COMPONENT AND DESCRIPTION	MANU-FACTURER	MANUFAC-TURER'S PART NUMBER	JAN OR NAME TYPE DESIGNATION	ALL SYMBOL DESIGNATIONS INVOLVED
		FUSES (Cont)			
F-2	FUSE: 1/32 amp; Fustron; glass tube; dual element; 1/4" x 1-1/4".	4	Type MDL		F-2
		INDICATING DEVICES			
I-1	LIGHT, INDICATOR: 1-11/32" red jewel type; material metal with solder lug terminals; lamp 6v brown bead mazda; bayonet type base.	10	40		I-1
		JACKS			
J-1	JACK: .25" round brass rod; 10 amps; 1500 Volts when used with black bakelite body; Weston dwg. #118922.	21	DWG. #118923		J-1
J-2	JACK: .156" diam phosphor bronze; 10 amps; 1500 Volts when used with black Bakelite body; Weston dwg. #106262.	21	DWG. #106253		J-2 J-3
J-3	Same as J-2.				
J-4	JACK, PLATE ASSEMBLY: 1 amp max or 1500 volts max.	21	DWG. #150594		J-4
		METERS			
M-1	METER: 50 MA-dc; 5000 ohms; rectangular flush black bakelite case; multiarc scale. With black and red figures on a white background; ranges; Voltmeter-up to 1200 Volts AC or DC; capacitance-up to 1000 mfd; ohmmeter-up to 2000 megohms.	21	DWG. #138546		M-1

CIRCUIT SYMBOL	NAME OF COMPONENT AND DESCRIPTION	MANU-FACTURER	MANUFAC-TURER'S PART NUMBER	JAN OR NAME TYPE DESIGNATION	ALL SYMBOL DESIGNATIONS INVOLVED
			RESISTORS		
R-1	RESISTOR, VARIABLE: wire-wound; 50,000 ohms; ±5%; 15 watts; capacitor voltage control.	9	Model 271 part No. R-22.259		R-1
R-2	RESISTOR, FIXED: carbon; 170,000 ohms; ±1%; 1 watt.	13	Type DCF		R-2
R-3	RESISTOR, FIXED: carbon; 100,000 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-3
R-4	RESISTOR, FIXED: carbon; 585 megohms; ±2%; 15 K.V.; p/o W-6.	13	Manufactured per Weston dwg. 138545		R-4
R-5	RESISTOR, FIXED, WIRE-WOUND: 45,000 ohms; ±0.5%; 1/4 watt.	21	136099		R-5
R-6	RESISTOR, VARIABLE: wire-wound; 3,500 ohms; ±3%; 3 watts; capacity control.	7	Type 58		R-6
R-7	RESISTOR, VARIABLE: wire-wound; 775 ohms; ±3%; 3 watts; Power factor control with a SPST switch (S-8); Switch in ON position at counterclockwise position of control.	7	Type 58S		R-7
R-8	RESISTOR, FIXED; WIRE-WOUND: 63.6 ohms; ±0.5%; 1/4 watt.	21	DWG. #136095		R-8
R-9	RESISTOR, FIXED, WIRE-WOUND: 12.71 ohms; ±0.5%; 1/4 watt.	21	DWG. #136093		R-9
R-10	RESISTOR, FIXED, WIRE-WOUND: 6.36 ohms; ±0.5%; 1/4 watt.	21	DWG. #136092		R-10

CIRCUIT SYMBOL	NAME OF COMPONENTS AND DESCRIPTION	MANU-FACTURER	MANUFAC-TURER'S PART NUMBER	JAN OR NAME TYPE DESIGNATION	ALL SYMBOL DESIGNATIONS INVOLVED
	RESISTORS (Cont)				
R-11	RESISTOR, FIXED, WIRE-WOUND: 1.27 ohms; ±0.5%; 1/4 watt.	21	DWG. #136091		R-11
R-12	RESISTOR, FIXED, WIRE-WOUND: .636 ohms; 0.5%; 1/4 watt.	21	DWG. #136090		R-12
R-13	RESISTOR, FIXED, WIRE-WOUND: .212 ohms; 0.5%; 1/4 watt.	21	DWG. #136089		R-13
R-14	RESISTOR, FIXED: carbon; 7.5 megohms; 0-2%; 1/2 watt.	22	CPL 1/2		R-14
R-15	RESISTOR, FIXED: carbon; 5.625 megohms; 0-2%; 1/2 watt.	22	CPL 1/2		R-15
R-16	RESISTOR, FIXED: carbon; 1.125 meg-ohms; 0-2%; 1/2 watt.	22	CP 1/2		R-16
R-17	RESISTOR, FIXED: carbon; 562,500 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-17
R-18	RESISTOR, FIXED: carbon; 112,500 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-18
R-19	RESISTOR, FIXED: carbon; 56,250 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-19
R-20	RESISTOR, FIXED: carbon; 18,750 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-20, R-49
R-21	RESISTOR, FIXED, WIRE-WOUND: 900 ohms; ±0.5%; 1/4 watt.	21	DWG. #136098		R-21
R-22	RESISTOR, FIXED, WIRE-WOUND: 100 ohms; ±0.5%; 1/4 watt.	21	DWG. #136096		R-22

CIRCUIT SYMBOL	NAME OF COMPONENT AND DESCRIPTION	MANU-FACTURER	MANUFAC-TURER'S PART NUMBER	JAN OR NAME TYPE DESIGNATION	ALL SYMBOL DESIGNATIONS INVOLVED
	RESISTORS (Cont)				
R-23	RESISTOR, FIXED: carbon; 30,000 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-23, R-30
R-24	RESISTOR, FIXED: carbon; 300,000 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-24
R-25	RESISTOR, FIXED: carbon; 30 megohms; ±0.2%; 1 watt.	22	CPL 1		R-25
R-26	RESISTOR, FIXED, WIRE-WOUND: 29.6 ohms; ±0.5%; 1/4 watt.	21	DWG. #136094		R-26
R-27	RESISTOR, FIXED, WIRE-WOUND: 270.4 ohms; ±0.5%; 1/4 watt.	21	DWG. #136097		R-27
R-28	RESISTOR, FIXED: carbon; 2700 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-28, R-38
R-29	RESISTOR, FIXED: carbon; 15,000 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-29
R-30	Same as R-23.				
R-31	RESISTOR, FIXED: carbon; 34,300 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-31
R-32	RESISTOR, FIXED: carbon; 120,000 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-32, R-33
R-33	Same as R-32.				
R-34	RESISTOR, FIXED: carbon; 12 megohms; ±10%; 1/2 watt.	13	BTS 1/2		R-34
R-35	RESISTOR, FIXED: carbon; 3500 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-35

CIRCUIT SYMBOL	NAME OF COMPONENT AND DESCRIPTION	MANU-FACTURER	MANUFAC-TURER'S PART NUMBER	JAN OR NAME TYPE DESIGNATION	ALL SYMBOL DESIGNATIONS INVOLVED
	RESISTORS (Cont)				
R-36	RESISTOR, VARI-ABLE: Wire-wound; 1,000 ohms; ±10%; 4 watts; zero set control.	16	Type M		R-36
R-37	RESISTOR, FIXED: carbon; 3000 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-37, R-51
R-38	Same as R-28.				
R-39	RESISTOR, FIXED: carbon; 200,000 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-39
R-40	RESISTOR, FIXED: carbon; 450,000 ohms; ±1%; 1 watt.	22	CP 1		R-40
R-41	RESISTOR, FIXED: carbon; 15 megohms; ±0.2%; 1 watt.	22	CPL 1		R-41
R-42	RESISTOR, FIXED: carbon; 166,000 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-42
R-43	RESISTOR, FIXED: carbon; 20,000 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-43, R-44
R-44	Same as R-43.				
R-45	RESISTOR, VARI-ABLE: carbon; S-taper; 25,000 ohms; ±20%; 1/2 watt.	7	Type 37		R-45
R-46 A&B	RESISTOR, VARI-ABLE: wire-wound; dual; 5000 ohms each; ±10%; 2 watts; Sensi-tivity control.	7	Type 43		R-46A&B, R-50A&B
R-47	RESISTOR, FIXED: carbon; 4700 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-47
R-48	RESISTOR, FIXED: carbon; 4300 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-48

CIRCUIT SYMBOL	NAME OF COMPONENT AND DESCRIPTION	MANU-FACTURER	MANUFAC-TURER'S PART NUMBER	JAN OR NAME TYPE DESIGNATION	ALL SYMBOL DESIGNATIONS INVOLVED
	RESISTORS (Cont)				
R-49	Same as R-20.				
R-50 A&B	Same as R-46A&B.				
R-51	Same as R-37.				
R-52	RESISTOR, FIXED: carbon; 6000 ohms; ±1%; 1/2 watt.	22	CP 1/2		R-52
R-53	RESISTOR, FIXED: carbon; 1000 ohms; ±10%; 1/2 watt.	2	Type EB #1021		R-53
R-54	RESISTOR, FIXED: carbon; 5.1 megohms; ±10%; 1/2 watt; p/o W-4.	13	Type BTS-1/2		R-54
R-55	RESISTOR, FIXED: carbon; 180 ohms; ±10%; 1/4 watt.	13	Type BTR-1/4	RC10AF181K	R-55
	RESISTOR, FIXED; carbon; 330 ohms; ±10%; 1/2 watt; 50 out of 100 instruments may have this resistor for R-55.	13	Type BTS-1/2	RC20AF331K	R-55
	RESISTOR, FIXED: carbon; 470 ohms; ±10%; 1/2 watt; 10 out of 100 instruments may have this resistor for R-55.	13	Type BTS-1/2	RC20AF471K	R-55
R-56	RESISTOR, FIXED: carbon; 5.6 ohms; ±10%; 1/2 watt.	13	Type BW-1/2	RU3B5R6K	R-56
R-57	RESISTOR, FIXED: carbon; 510,000 ohms; ±10%; 1/2 watt.	13	Type BTS-1/2		R-57

R-58 RESISTOR, FIXED Continental "Nobleloy" X-5, 26.25 megohms ± 1%, 5 watts. National Supply Catalog No. 11—768.11

CIRCUIT SYMBOL	NAME OF COMPONENT AND DESCRIPTION	MANU-FACTURER	MANUFAC-TURER'S PART NUMBER	JAN OR NAME TYPE DESIGNATION	ALL SYMBOL DESIGNATIONS INVOLVED
			SWITCHES		
S-1	SWITCH, TOGGLE: DPDT; 6 amps; 125 v; bat handle; bushing 15/32" dia. x 32 threads; non-shorting contact.	3	81027-F.P.		S-1
S-2	SWITCH, TOGGLE: DPDT; 6 amps; 125 v; bat handle; spring return; bushing 15/32" dia. x 32 threads; non-shorting contact.	3	81057H		S-2
S-3	SWITCH, ROTARY: four gang; 6 position; 60 watts; silver plated rotor and stator contacts; shorting type contacts; open construtions; exterior shaft 3/8"; single hole mounting.	17	Type H		S-3
S-4	SWITCH, TOGGLE: SPDT; spring return; otherwise same description as S-1.	3	81051D		S-4
S-5	SWITCH, ROTARY: four gang; 6 position; 60 watts; otherwise same description as S-3.	18	Type H		S-5
S-6	SWITCH, TOGGLE: SPDT; otherwise same description as S-1.	3	81021-FJ		S-6
S-7	SWITCH, ROTARY: four gang; 9 position; 60 watts; silver plated rotor and stator contacts; shorting type contacts; open construction; exterior shaft 3/8"; single hole mounting.	18	Type L		S-7

CIRCUIT SYMBOL	NAME OF COMPONENT AND DESCRIPTION	MANU-FACTURER	MANUFAC-TURER'S PART NUMBER	JAN OR NAME TYPE DESIGNATION	ALL SYMBOL DESIGNATIONS INVOLVED
	SWITCHES (Cont)				
S-8	Part of R-7: SPDT; 3 amps; 120 v less than 5 ohms runoff after switch is in "ON" position, normally "ON" at counterclockwise rotation.		See R-7		
	TRANSFORMERS				
T-1	TRANSFORMER, POWER: 115 Vac; 60 cycles; single phase; five windings; 4 secondary windings; 860 v center tap; 57.8 v; 6.1 v; 6.1 v; 3.75" lg. x 3" high; twelve solder terminals; four 3/16" holes on 2.50" x 3.125" mounting circles.	21	SWG. #138511		T-1
	TUBES				
V-1	F-W Rectifier: 6X4.				V-1
V-2	Amplifier: 12AU7.				V-2
V-3	Voltage Regulator: 991.				V-3
V-4	CK5704: p/o W-4.				V-4
	LEADS				
W-1	LEAD, ELECTRICAL: #18 AWG stranded copper conductor; black rubber insulation; 1000 volts ac; 9 feet lg; standard 2 prong male wall plug; other end plain.	12	DWG. #135922		W-1

CIRCUIT SYMBOL	NAME OF COMPONENT AND DESCRIPTION	MANU-FACTURER	MANUFAC-TURER'S PART NUMBER	JAN OR NAME TYPE DESIGNATION	ALL SYMBOL DESIGNATIONS INVOLVED
	LEADS (Cont)				
W-2	LEAD, ELECTRICAL: #36 tin copper wire; black rubber insulation; 1200 volts; 4 feet lg; .081" dia. pin-tip; other end .081" dia. tip for test prod with .165" dia. shank.	21	DWG. #70033		W-2
W-3	LEAD, ELECTRICAL: red rubber insulation; otherwise same description as W-2.	21	DWG. #70034		W-3
W-4	RF PROBE ASSEMBLED: 4-1/4" lg. x 3/4" dia. overall; cable 55" lg; A.C. measurements from 50 to 150 megacycles and 150 to 300 megacycles with correction curves; contains C-10, R-54, and V-4.	21	DWG. #138520		W-4
W-5	GROUND LEAD, R.F. PROBE: #36 tin copper wire; black rubber insulation; 600 volts; 2-1/2" lg; 3/4" ring term on one end alligator clip on other.	21	DWG. #118974		W-5
W-6	HIGH VOLTAGE PROBE ASSEMBLED: Polystrene const.; tip extension 8-5/8" lg x 1-3/4" dia. at fins; handle 4-1/2" lg x 2-1/2" dia. at fin; cable 53" lg; D.C. measurements to 12000 volts; contains R-4.	21	DWG. #138536		W-6

W-7 PATCH CORD, 7-inches with pin tips. National Supply Catalog No. 30-8420.5

CIRCUIT SYMBOL	NAME OF COMPONENT AND DESCRIPTION	MANU-FACTURER	MANUFAC-TURER'S PART NUMBER	JAN OR NAME TYPE DESIGNATION	ALL SYMBOL DESIGNATIONS INVOLVED
		SOCKETS			
XF-1	FUSEHOLDER: extractor post type; 8 AG cartridge fuse; 1/4" OD x 1" lg; phenolic; 250 volts; 5 amps. max; 2 solder terminals.	15	CAT. #371001		XF-1
XF-2	FUSEHOLDER: 1/4" x 1-1/4"; 3 AG "SLO-BLO" cartridge fuse; otherwise same description as XF-1.	15	CAT. #341001		XF-2
XV-1	SOCKET: 7 pin miniature; shield base.	6	3EFB #9356		XV-1
XV-2	SOCKET, NOVAL: 9 pin; shield base; 1-1/8" mtg. centers; top panel mtg; 1/8" mtg. holes.	6	CAT. #12825 Type 6		XV-2
XV-3	FUSE CLIP: without ears; N.E.C. 30 fuse size (socket for 991 voltage regulator).	15	CAT. #107002		XV-3
		BATTERIES			
BT-1	BATTERY: 1-1/2 volts; 1-cell leak proof; flashlight type.	19	2LP		BT-1

LIST OF MANUFACTURERS

SYMBOL	MANUFACTURER
1	Aerovox Corporation New Bedford, Massachusetts
2	Allen-Bradley Company 118 West Greenfield Avenue Milwaukee, Wisconsin
3	Arrow Hart & Hegeman Electric Company 157 Federal Street Boston, Massachusetts
4	Bussmann Manufacturing Company 2538 West University Street St. Louis, Missouri
5	Central Radio Laboratories 900 East Keefe Avenue Milwaukee, Wisconsin
6	Cinch Manufacturing Corporation Brooklyn, New York
7	Clarostat Manufacturing Company, Inc. Dover, New Hampshire
8	Cornell-Dubilier Corporation 1000 Hamilton Boulevard South Plainfield, New Jersey
9	De Jur Amsco Corporation 45-01 Northern Blvd. Long Island City 1, New York
10	Drake Manufacturing Company 1713 West Hubbard Street Chicago 22, Illinois
11	Erie Resistor Corporation 644 West 12th Street Erie, Pennsylvania
12	Hatfield Wiring Cable Company Hillside, New Jersey
13	International Resistance Company 401 North Broad Street Philadelphia 8, Pennsylvania
14	E. F. Johnson Company Waseca, Minnesota

LIST OF MANUFACTURERS (Cont)

SYMBOL	MANUFACTURER
15	Littelfuse Products Inc. 4757 Ravenswood Avenue Chicago 40, Illinois
16	R. P. Mallory & Company 1941 Thomas Street Indianapolis, Indiana
17	Micamold Products Company 1087 Flushing Avenue Brooklyn, New York
18	Oak Manufacturing Company 1260 Clybourne Avenue Chicago 10, Illinois
19	Ray-O-Vac Company Madison, Wisconsin
20	Sangamo Electric Company Marion, Illinois
21	Weston Electrical Instrument Corp. 614 Frelinghuysen Avenue Newark 5, New Jersey
22	Wilkor Products, Inc. 3835 West 150th Street Cleveland 11, Ohio

See EEM 122 re addition of Resistor R-58, 26.2 megohms, on decks 4A and 4B, Switch S-3

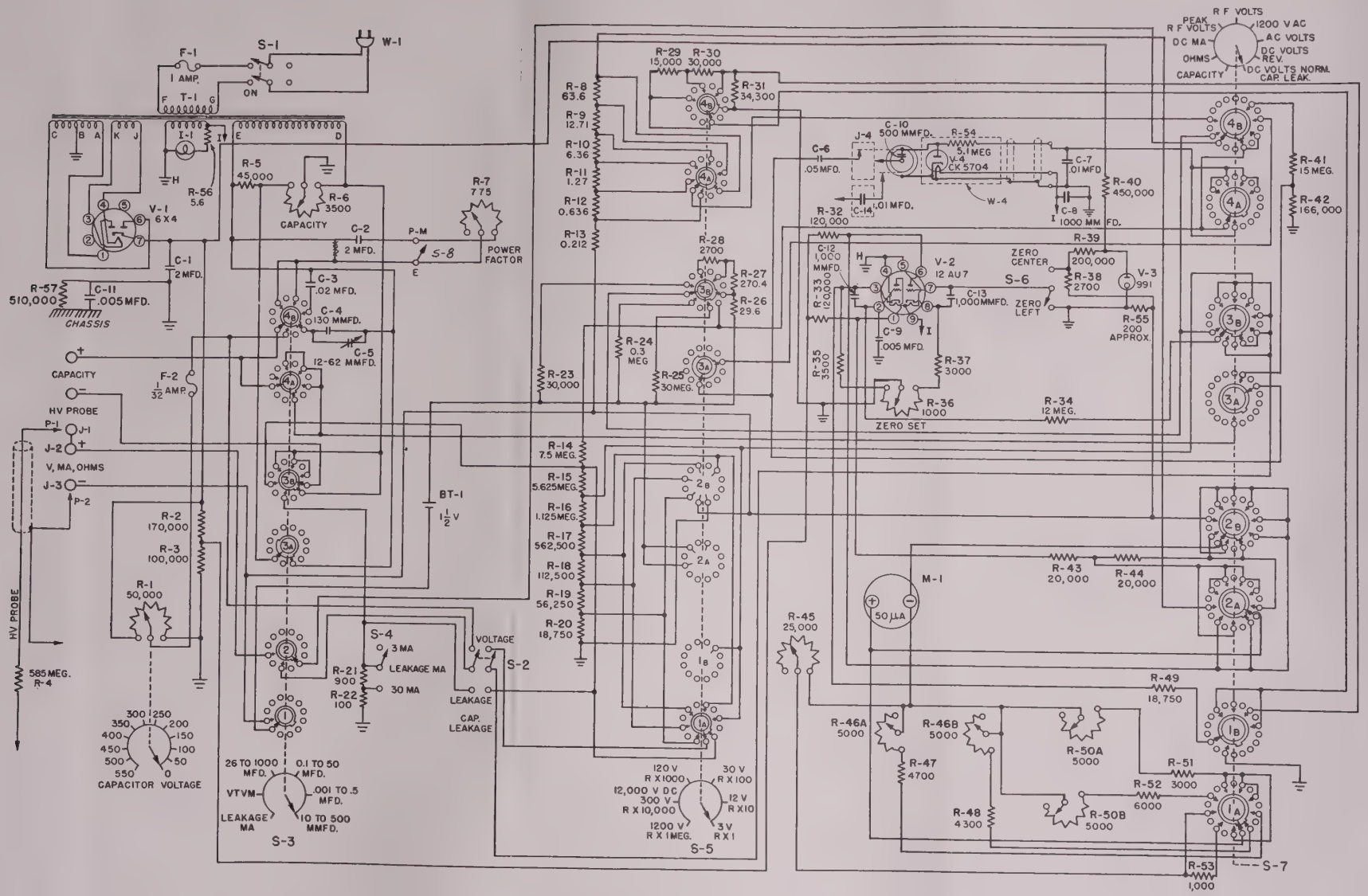


Figure 15. Schematic Diagram of Model 976 Electronic Multimeter

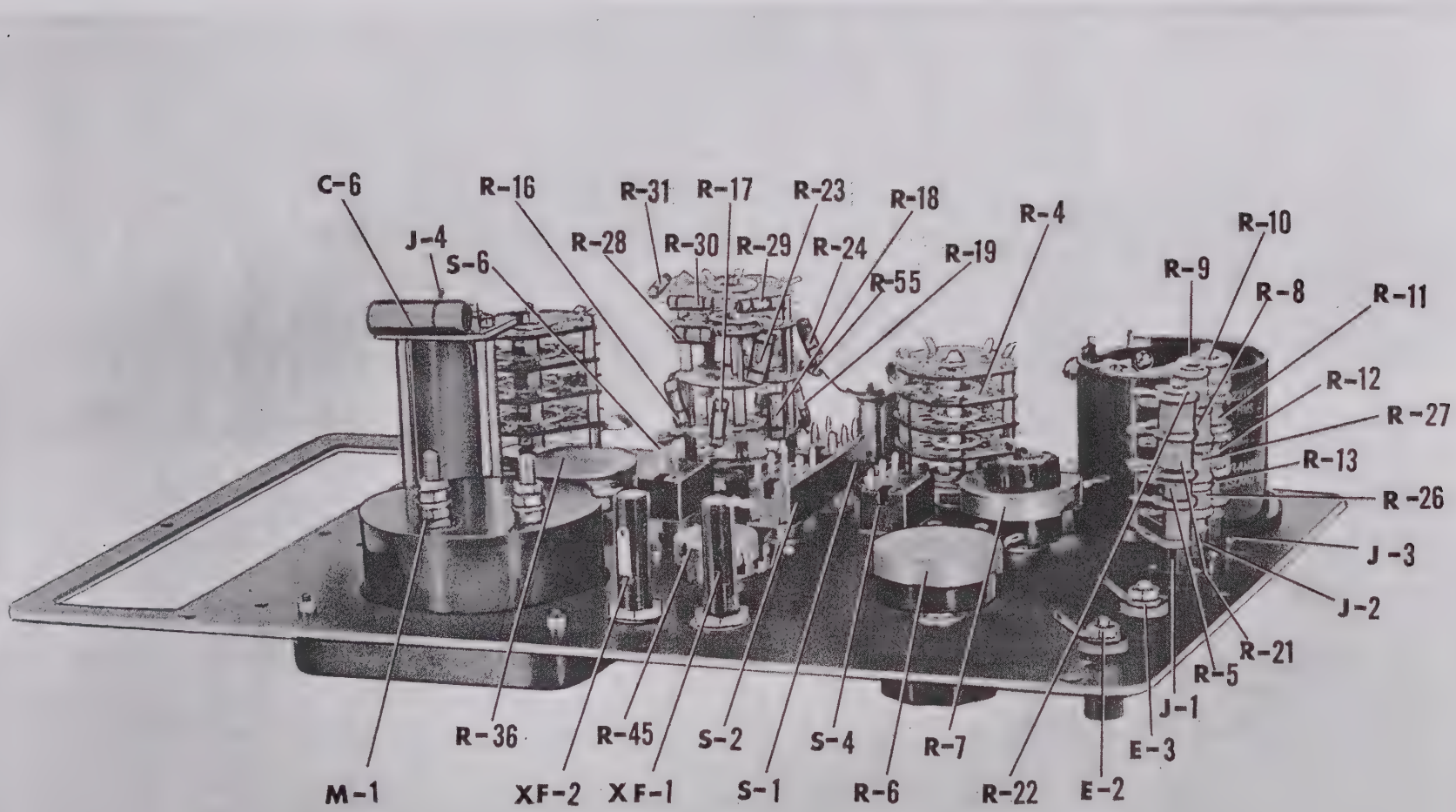


Figure 16. Model 976 Rear Panel, Less Sub-Chassis Assembly

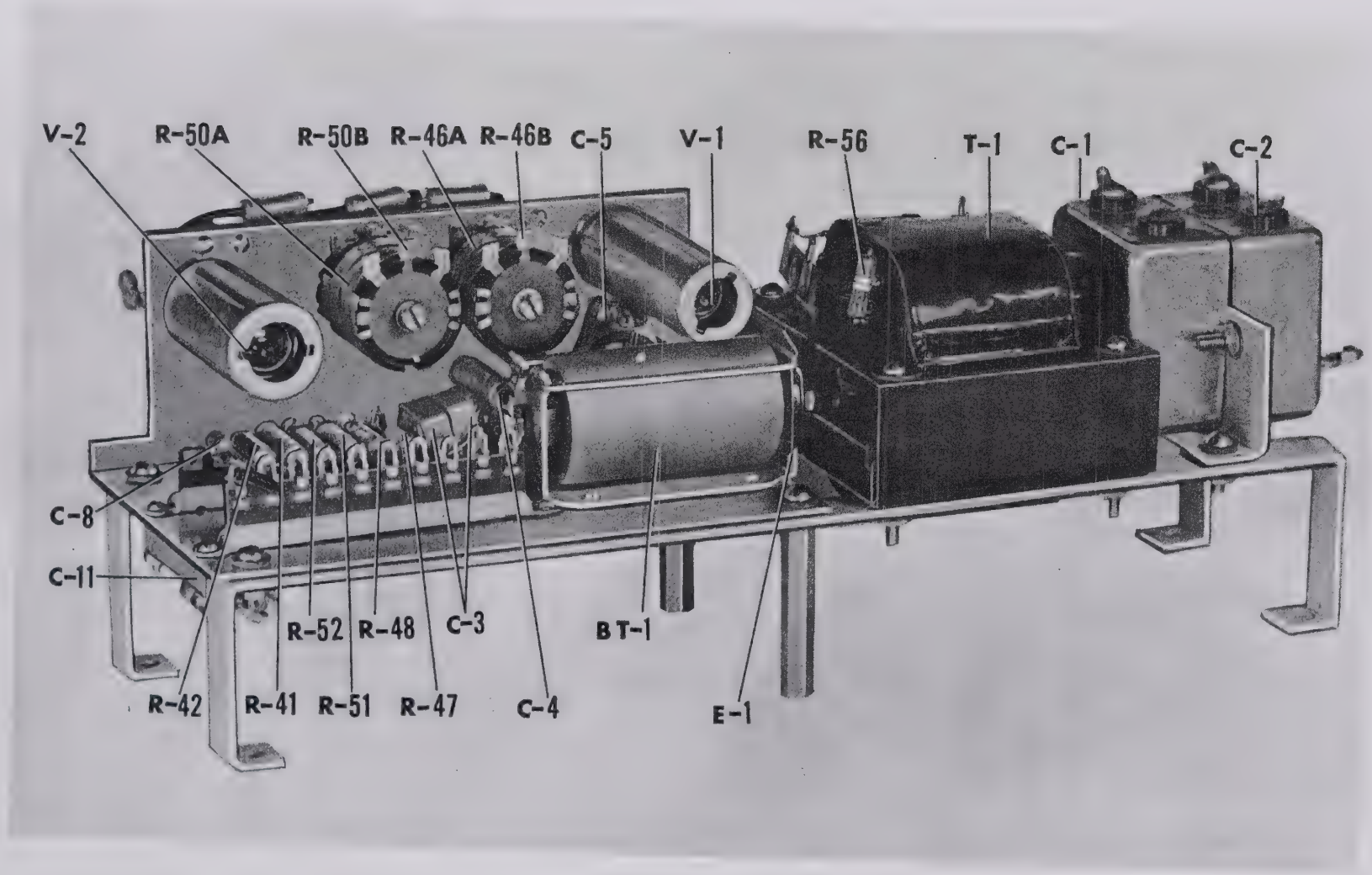


Figure 17. Model 976 Sub-Chassis Assembly, Front View

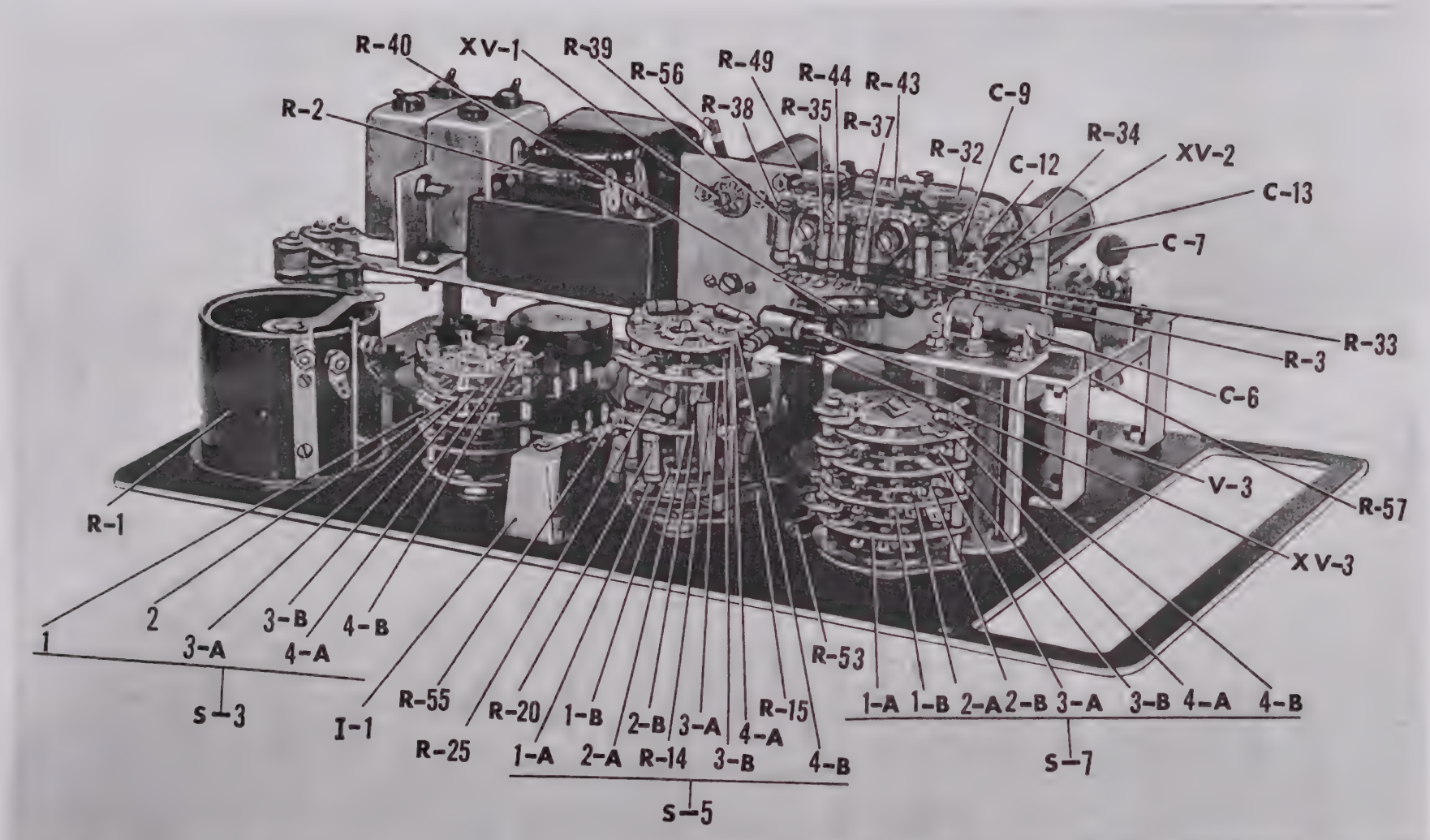


Figure 18. Model 976 Rear Panel, Complete

See EEM 122 re addition of Resistor R-58, 26.25 megohms, on decks 4A and 4B, switch S-3.

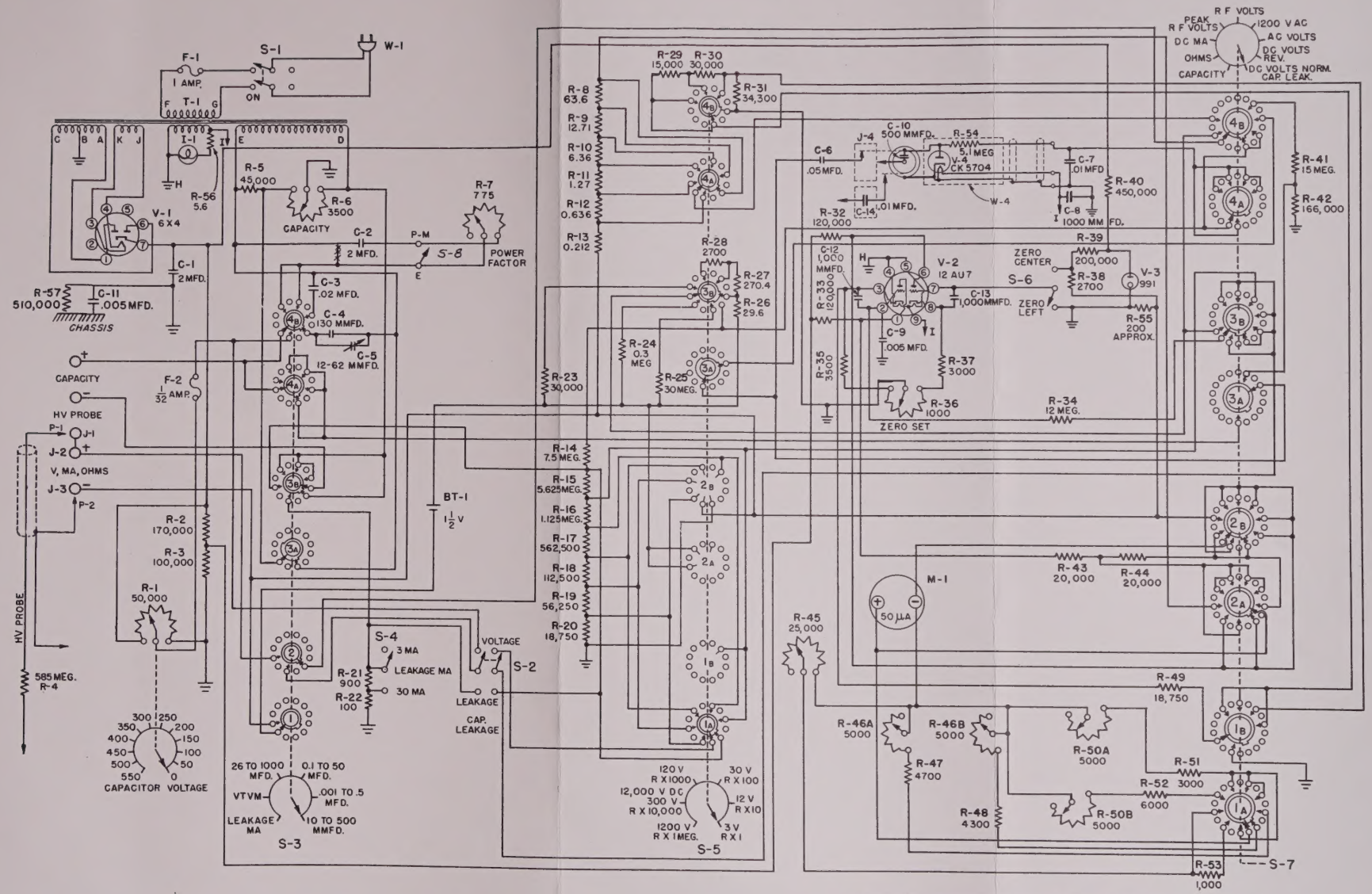


Figure 15. Schematic Diagram of Model 976 Electronic Multimeter

MP MASTER
MA35466